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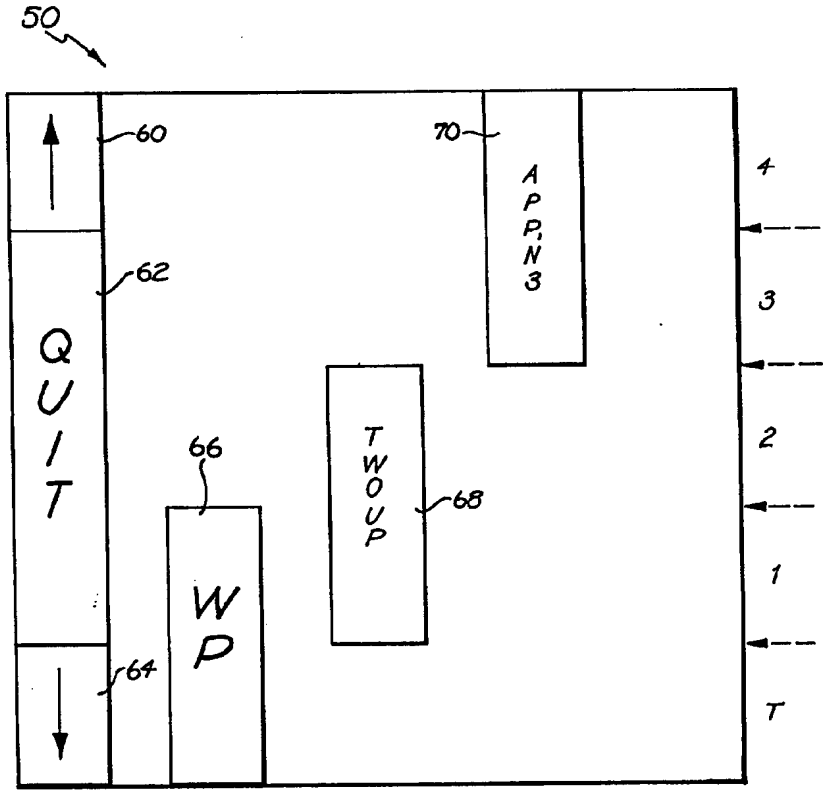
(54) Title: A HUMAN/MACHINE INTERFACE FOR COMPUTING DEVICES

(57) Abstract

A computing device having a human/machine interface is disclosed. An input device (10) has a plurality of keys (T, 1, 2, 3, 4) each corresponding to a separate digit of the human hand. The keys (T, 1, 2, 3, 4) are arranged to match the relative sequential relation of the digits. The input device (10) is coupled to a processor device (30), in turn coupled to a visual display device (50). The processor device (30) receives instructions or data from the input device (10) and outputs information to be displayed to the display device (50). The processor device (30) is programmed to cause the visual display of indicia (60-70) wherein each indicium represents a user initiated instruction or data input and is displayed in one-to-one correspondence with the sequential relation of one or more of the keys (T, 1, 2, 3, 4).



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A Human/Machine Interface for Computing Devices

Field of the Invention

This invention relates to a human/machine interface for computing devices. The interface is particularly, but not exclusively, suited to use with computing devices implemented in a compact format, and for computing devices to be used in mobile and adverse environments.

Background of the Invention

A particular type of human/machine interface is termed a graphical user interface, and basically is constituted by software resident in a computing device that translates instructions or data to visual information to be displayed on a visual display device.

One simple form of graphical user interface is text-based and utilises cursor control to enable navigation about a screen, however the predominant trend in known graphical user interfaces is the use of "windowing" systems that operate by 'point and click' actions by the user. Examples of windowing software systems are Apple QUICKDRAW, Microsoft WINDOWS and XWINDOWS created by MIT. Often windowing interfaces also incorporate the earlier form of cursor control, giving the user some form of flexibility in operation of the computing device, particularly with respect to data input. The icons and windowing structures presented to the user do not, however, provide access to the galaxy of commands and operations, so it is always necessary for the user to resort to operation of the keys of a conventional qwerty keyboard. There thus is the need for the user to learn and remember the qwerty keyboard layout.

Other examples of human/machine interfaces can be obtained from the text "Cognitive Aspects of Visual Languages & Visual Interfaces", edited by M.J. Tauber et al, published by North-Holland, Amsterdam, 1994.

Conventional user input devices such as keyboards, mouses and track balls require a benign and stable environment since the user must exhibit fine nervous system motor control in the use of the fingers. Mobile environments do not lend themselves to such fine movements, and can make operation of computing devices impracticable or even impossible.

The present invention is directed to overcoming or at least ameliorating one or more of the disadvantages noted above. Alternatively, or additionally, it can also be said to provide a useful alternative to known human/machine interfaces.

The present invention is directed to a human/machine interface that operates on the principle of 'what you see is what you press', and therefore removes the need for the user to be familiar with operational commands or the qwerty keyboard layout, rather maps input keystrokes directly from the display to the input device.

The human/machine interface of the present invention is particularly suited to use: (a) underwater, where there is a restricted range of human movement; (b) in a terrestrial mobile environment, (i.e. particularly 'wearable computers' and in vehicle-borne situations) where high levels of motion make it difficult for the user to operate a computing device via an input device; and (c) in airborne environments, where there are again high levels of motion acting on the user of the computing device.

It is convenient now to define some of the terminology that is used throughout the specification.

The fingers and thumb of the human hand are referred to as "digits". The term "digits" also embraces toes.

A "key" is to be understood as an input transducer operated by a single digit, and can include a pushbutton, switch, force transducer or the like. An "input device" typically can have four keys, one for each of the fingers, and one or more "keys" for the thumb, given that the thumb has greater dexterity than the fingers. Even so, there can be any number of keys in the range 1 to 5. The activation/operation of one or a combination of the keys at the same time is referred to as a "chord". A "couplet" is

two consecutive chords, or two simultaneous chords performed by the left and right hand.

A "display device" is to be understood a hardware element such as a video monitor or liquid crystal display. The display device thus presents the viewer with an image that, for convenience, will be termed a "display".

A display visually presents "indicia". An indicium is presented in a manner that represents one or more keys. A number of indicia in close spatial or sequential arrangement is termed a "panel". Each panel overlays a number of notional non-overlapping sequential regions. In that sense the regions can also be thought of as partitioning a portion of the display. An indicium can span over one or more regions in the sense that it is oriented substantially orthogonally to the regions. An indicium itself can be either contiguous or discontiguous. An indicium also is referred to as a "button".

Summary of the Invention

Therefore, in one form the invention discloses a computing device having a human/machine interface comprising:

an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits;

a visual display device; and

a processor device receiving instructions or data from the input device and outputting information to the display device, the processor device being programmed to cause the visual display of indicia, and wherein each indicium represents a user initiated instruction or data input and is displayed in one-to-one correspondence with the sequential relation of one or more of the keys.

Preferably, in use the computing device, a user temporally notionally partitions the visual display of the display device into a plurality of non-overlapping regions, each region corresponding to one of the digits, and the regions being in the same sequential

relation as the digits, and whereby any one or more regions intersected by an indicium corresponds to the combination of keys that give effect to the instruction or data input represented by the indicium.

Preferably, the indicia and the regions are arranged orthogonally.

Preferably, there are five keys, and therefore five notional regions.

Advantageously, some of the user initiated instructions or data inputs correspond to at least two discrete combinations of keys.

Preferably, the indicia are arranged within a panel, and a number of panels can be displayed on the display device. A panel can be coterminous with the corresponding regions.

Preferably, the input device further comprises at least two extra keys, each operable by a respective opposite articulation of the thumb with respect to the thumb key, each extra key being visually displayed on the display means by a separate indicium, such as a thumbline arranged to be either atop a panel or below a panel respectively to indicate the direction of articulation of the thumb.

The invention in another form further discloses a human/machine interface program for implementation on a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits, a visual display device and a processor device to give effect to the program, the program comprising:

an input element to receive instructions or data from the input device;

an output element to pass display information to the display device; and

a processing element, coupled to the input element and the output element, to cause the display of indicia, and wherein each indicium represents a user initiated instruction or data input and is displayed in one-to-one correspondence with the sequential relation of one or more of the keys.

In a preferred form, some of the user initiated instructions or data inputs correspond to at least two discrete combinations of keys.

The invention in a yet further form discloses a method for implementing a human/machine interface for a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits, and a visual display device; the method comprising the steps, implemented on processor means, of:

visually displaying indicia on the display device, each indicium being in one-to-one correspondence with the sequential relation of one or more of the keys, thereby to allow input of an instruction or data represented by each indicium by the respective one or more keys.

Preferably, in practice of the method a user performs the steps of:

notional partitioning the visual display device into a plurality of non-overlapping regions, each region corresponding to a key and being arranged with the same sequential relation as the digits; and

activating the one or more keys corresponding to the one or more regions intersected by an indicium to give effect to the instruction or data input represented by the indicium.

Preferably, there are five keys, and therefore five notional regions.

Preferably, the method further comprises the steps of displaying two extra indicia, each extra indicium corresponding to a shifted state of the user's thumb, thus providing for implementation of further instructions or data inputs.

The invention yet further discloses a method for implementing a human/machine interface for a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation to the digits, and a visual display device; the method comprising the step, implemented on processor means, of:

displaying a regular array of indicia on the display device, each row and column of the array respectively being in correspondence, in an orthogonal manner,

with the sequential relation of one or more of the keys, and each indicium corresponding to a sequence of a row and a column key, thereby to allow input of instruction or data represented by each indicium by the respective sequence of keys.

In a most preferred form the sequence of the keys commences with the thumb.

Brief Description of the Drawings

Embodiments of the invention now will be described with reference to the accompanying drawings, in which:

Figs. 1a and 1b show schematic arrangements of a computing device for implementing a man/machine interface;

Fig. 2 shows a functional block diagram for the computing device of Figs. 1a and 1b;

Fig. 3 shows a display presented to the user in use of the man/machine interface;

Fig. 4 shows another display;

Fig. 5 shows a pull-out display arrangement;

Fig. 6 shows a yet further display illustrating shifted states;

Figs. 7a and 7b show an example of a pop-up display arrangement;

Figs. 8a, 8b, 8c and 8d show sets of chords for a number of different indicia-representations;

Fig. 9 shows an arrangement for a numerical pad;

Fig. 10 shows a virtual typewriter;

Fig. 11 shows a virtual calculator;

Fig. 12 shows a further display of cross panels;

Figs. 13, 14, 15a, 15b, 16a and 16b show yet further chord arrangements;

Figs. 17a-17c show a segmenting cursor arrangement;

Figs. 18a and 18b show a segmenting pointer arrangement;

Fig. 19 shows the mechanical arrangement of an input device;

Figs. 20a and 20b show the mechanical arrangement of a further input device;

Fig. 21 shows a conventional qwerty keyboard layout; and

Figs. 22 to 24 are flow diagrams supporting the methodology of embodiments of the invention.

Description of Preferred Embodiments

Fig. 1a shows a schematic arrangement for the human/machine interface implemented on a computing device. An input device 10 is coupled with a processing device 30, in turn coupled with a display device 50. The input device 10 has five input keys which are denoted as 4,3,2,1 and T. As is apparent from the representation of the human hand, each of the fingers and the thumb correspond sequentially to the like-referenced keys, and any activation of one or a combination of keys produces "a chord". Fig. 1b shows two thumb keys C,A in addition to the T key that serve a special function which presently will be described.

The processing device 30 can be any off-the-shelf personal computer, although for mobile applications should be compact and rugged in nature; for example, in the PC/104 format. The display device 50 also can be conventional, although again it is preferred that it be as compact as possible, and in this respect the PRIVATE EYE (TM) device manufactured by Reflection Technology, Inc. is particularly suitable.

In operation, the processing device 30 causes a display of information on the display device 50. In response to that information, the user inputs instructions or data by means of keyed chords. Indicia displayed on the display 50 corresponds directly to a particular chord, thus giving effect to either the instruction or data input represented by the indicium. As noted above, the principle is essentially 'what you see is what you press'.

Fig. 2 shows a functional block diagram of a computing device upon which the human/machine interface can be implemented. The input device 10 comprises a multi-switch unit 20 constituted by the keys 4-1,T shown in Fig. 1a. The switch unit 20 is connected to a debounce and latch circuit 22 that is configured to output signals only on release of the keys, as opposed to on initial depression of the keys. In this way,

individual keys in a combination of keys can be depressed separately in time, however only the total combination is signalled when all those keys are coincidentally released. The output from the debounce and latch circuit 22 passes to a bi-directional parallel port 24 of a conventional type, with the output thereof constituting a bit pattern that can be decoded by the software resident in the processing device 30. In one preferred form the input bit pattern is binary coded leading to a raw decimal value for any chord as a combination of key presses.

In the same way as a conventional keyboard inputs to a personal computer, the input bit pattern functions as an interrupt to the operating system. The interrupt function is represented by the interrupt handler 32. The interrupts then pass via an input parser 34 to a command manager 36. The command manager 36 interacts with the host operating system 38, a feedback manager 40 and associated audio handler 42 and applications software 44. The command manager 36 also co-operates with the visual handler 46 which in turn drives the display device 50.

The audio handler serves a particular function in providing an auditory feedback mechanism to the user on activation of any key. A pentatonic scaling is preferred, which is the division of one octave into five discrete frequencies. The division is not uniform, rather based on a temporal consideration of what sounds pleasant to the ear. A chording of more than one key results in the reproduction/feedback of the respective notes in combination. Pentatonic scales per se are well known.

The software component of the interface is essentially transparent to the user. The user is concerned only with display presented on the display unit 50 as it relates to the sequential relation of the keys equating or mapping onto the digits of the hand.

Fig. 3 shows a display presented on the display device 50. The display, in this instance is notionally (temporally) broken to five non-overlapping regions extending as bands across the display; the panel constituted by the displayed indicia/buttons 60-70 is equivalent in dimension to the whole display. The regions are shown indicated with the nomenclature corresponding to the keys/digits of Fig. 1a and 1b. The processing

device is not concerned with the notional partitioning, rather simply retains a page table of currently-displayed indicia indexed by raw chord value and compares the raw chord value input by the user in a look-up routine to give effect to the chorded instruction of data input.

The 'arrow' indicia 60,64 represent commands that can step through operating system levels, whilst the 'QUIT' indicium is a command used to terminate a session. The other three indicia 66-70 represent commands to implement either a word processing package, a "two-up" gaming application or another non-specific applications program.

Each of these regions maps directly onto (equates to) the relative sequential arrangement of the keys on the input device 10. That is, there is one-to-one correspondence of the sequential relation of one or more of the keys with the sequential relation of each indicium. The term sequential has been used, but the one-to-one correspondence in most cases can also be thought of as the spatial relation of the keys or the order of the keys, where that spatial relation or ordering is itself in one-to-one correspondence with the digits. The top-most region corresponds with the position of the little finger key 4, and so on to the bottom and the thumb key T. To give effect to any one of the indicia, the user selects the combination of keys (i.e. the chord) corresponding to the respective indicia. This is assessed by observing which regions are intersected by (overlapped, crossed, covered, extended-over, or coincident with) an indicium.

For example, in order to action the 'QUIT' command, the user activates (chords) the keys "3,2,1" in combination. To give effect to the WP application, the user chords key combination "1 & B". 'TWO UP' is effected by the key combination "2 & 1", and 'APP'N 3' is accessed by the key combination "4 & 3". The user simply identifies which regions are intersected by whichever indicium, then chords what is observed.

In this example, the one panel (i.e. the set of indicia), and hence the five regions, extends over the whole area of the display. It is equally the case that a panel

and the associated regions may not extend over the whole area of the display, so long as the relative sequential relation of regions be maintained in one-to-one correspondence with the keys. It is equally applicable to arrange the regions to extend vertically of the display. In that case, the indicia would be horizontally extending. In essence, indicia and regions are orthogonal. It is further possible for the relative position of the thumb to be inverted such that it maps to the top of the screen, and therefore the little finger maps to the bottom of the screen. In view of these possibilities it is convenient to refer to a "thumb origin" to give a sense to the order of the keys to the indicia. In all cases the relative sequential relation between the digits/keys and the regions stays the same regardless of the specific orientation of the input device 10 or the display device 50. As has been previously noted, there may be less than five keys provided. The convention adopted is that the sequence always commences with the thumb, hence an input device with only three keys corresponds to the thumb and index and middle fingers.

Fig. 4 shows a subsequent display presented when the 'TWO UP' application program of Fig. 3 is selected. The display contains a panel 72 containing a number of indicia. Each indicium represents a command for use in playing of the 'TWO UP' coin toss game. The panel 72 is notionally divided into five regions, represented in the nomenclature previously indicated. Each of the indicia/buttons in the panel 72 is activated by a unique chord. The $10 button is operated by the "T/B" single key chord, the $5 button by the "1" single key chord, the 'CANCEL BET' button by the "T/B & 1" key chord, and the coin toss button by the chord formed by all the keys (ie. "T/B & 1 & 2 & 3 & 4").

The display also includes a 'hanging-down' panel 74 and a 'hanging-up' panel 76, each notionally partitioned into five regions that are arranged orthogonally to the regions of the other panel 72. These panels relate to specific functions associated with the extra thumb keys A & C, shown in Fig. 1b that correspond to the articulated thumb positions. The extra thumb keys A,C give effect to specific 'shift' functions. The

shifted states increase the instruction/data input set from a maximum 31 ($2\text{-}1^5$) combinations available with only five keys (T and 1-4).

The C key conveniently has been prescribed a pre-shift function, in that upon activation a shifted state is entered whereupon the subsequent chord takes on a different instruction or data entry value than it would had the C key not been depressed. Considering the example of Fig. 4, upon depression of the key C access is obtained to the hanging-down panel 74, and the five indicia contained therein. In this case, the five indicia each correspond with one region alone. It is, of course, possible to have any of the indicium extending over more than one region.

Another type of shift function is termed 'shift immediate'. This is effected by the A key. This situation is somewhat akin to the shift key to be found on a conventional keyboard, in that the key A forms an alternative to the key B when used alone, and also can be used in combination with the other keys 1-4. The hanging-up panel 76 is accessed by use of the A key in combination with keys 1-4.

Fig. 5 shows a section of the display of Fig. 4, particularly indicating the hanging-down pre-shift panel 74. Once the pre-shift key C is effected, the subsequent chord will give effect to one of the indicia. In the present example, the subsequent combination is the sequence of "3" key alone (being the EDIT function as highlighted). This results in a further panel 78 being 'pulled-out', and any subsequent chord gives accesses each one of the five indicia indicated in the new panel 78. Again, it is merely for the sake of convenience that the indicia corresponds one-to-one with the five regions.

Fig. 6 shows further arrangements for the representation of shifted states. Three 'floating' panels 80,82,84 are shown within the display 50. Each of these panels contains a number of indicia (not labelled), with each panel being notionally divided into five regions, as indicated, that sequentially map onto the keys. The indicia of the panel 80 are accessed without the use of either of the shift keys A,C. The panel 82 includes a 'thumbline' 88 (or 'baseline'), represented by the thickened line to the bottom of the panel. This thumbline 88 provides a visual indication that a shifted state

is required in order to access the indicia within the panel 82. The thumbline 88 being at the bottom of the panel indicates the need to depress the A key. In other words, a 'shift immediate' function will be effected as previously described. For the shift immediate function, there will only be four notional regions within the panel, as indicated. This is for reason of the thumb being used to activate the A key to enter the shift immediate state, thus leaving only the remaining four digits to be available for use. There is a certain logic to the thumbline arrangement, in that the thumb must be articulated downwardly away from the usual B key to activate the A key, and its downward sense is consistent with the thumbline 88 being to the bottom of the panel 82. The remaining floating panel 84 has a thumbline 90 located to the top. This indicates the need to articulate the thumb upwardly to operate the C key for a pre-shift state. In the pre-shift state there are five notional regions, as noted.

The display also includes a further panel 86 as an inverted L-shape in the top left hand corner of the display. The 'hanging-down' convention does not apply to this panel 86, rather the thumbline principle is in effect. The panel 86 is shown as a single panel, however contains two discrete sets of notional regions, hence more properly is two panels. The indicia appearing down the left hand side of the display are tied to the thumbline 92 appearing at the bottom edge thereof, and is notionally broken into the notional regions as indicated. Since the thumbline 92 is to the bottom of this part of the panel, it represents use of the A key, in which case there are only four regions as previously described. The indicia extending across the top edge of the display are tied to the other thumbline 94. This thumbline is again to the bottom edge of the panel, hence again represents use of the A key.

Fig. 7a shows a panel 96 incorporating five indicia. The notional regions corresponding to the keys also shown. If the "1" key is chorded, a further panel 98 pops-up. The further panel 98 contains five different indicia. As can be noted, the regions within the frame are orthogonal to those for the frame corresponding to the parent panel 96. A similar pop-up effect would occur for the other indicia of the first panel 96.

Figs. 8a and 8b show the complete set (or 'galaxy') of chords for a five-button input device. The dashed lines represent the boundary of five notional regions within which the indicia are bounded. The indicia are shaded, and for convenience are as a type termed "bar chords". Note that a number of the bar chords are not formed by a contiguous key press and these special chords are termed "hollow bar chords". Also shown beside each indicium is its "raw chord value". By a convention, the thumb origin is at the left hand side, and the notional regions are represented in a binary form so that any chord also can be represented as a unique decimal number - this is useful in an implementation of an embodiment of the invention as will become apparent. The binary convention is reversed, increasing from 0-31 from right to left, but equally could be increasing 0-31 from left to right.

Fig. 8c shows five different style of chord representations, for, as it turns out, the chords having the decimal values 1-5. The first (left-most) column shows bar chords for which the partitioning into five regions has to be visualised without a graphical prompt - compare this with the bar chords in the third column. In the second column, the boundary of the five regions is represented by the bottom horizontal line, and the key(s) to be chorded by the vertical line marks. This representation is termed "glyph chords". The fourth column represents the vertical, rather than horizontal orientation of bar chords, with the thumb origin occurring at the bottom. The fifth column representation of dots and line marks are termed "dot chords".

Fig. 8d shows the galaxy of glyph chords together with their raw chord value.

Fig. 9 shows a panel 104 in the form of a numeric keypad. All of the digits 0-9 are represented. The thumb origin is in the bottom left hand corner of the "1" indicium. The panel 104 is broken up into two parts, the first part being the 3 x 3 array 106 of the numerals 1-9, and the second part being the button 108 for the 0 numeral. The "0" button is activated by chording "T & 1 & 2". The other numerals are accessed by means of chording a "couplet". That is, in the 3 x 3 array each particular numeral button requires a separate sequential combination of two chords for it to be accessed. For example, the "1" button is accessed by the couplet "T" & "T",

whilst the "6" button is accessed by the couplet "1" & "3". Couplet chording is somewhat equivalent to the pop-up menus previously discussed, in as much as the popped-up buttons are always displayed rather than being hidden.

Fig. 10 shows a form of virtual typewriter, basically comprising two panels 110,112 side-by-side. The partition between the panels is represented by the vertical-line. The panel 110 comprises a 5 x 5 array of 25 buttons representing 25 letters of the roman alphabet. Activation of the respective letter buttons is by couplet chording. The thumb origin for the panel 110 is at the bottom left hand corner of the "e" button.

By way of example, the letter "r" button is activated by chording "2" & "2", and the "j" button is activated by chording "3" & "4". The "Space" button is activated by chording "T &1 & 2 & 3 & 4". The spatial arrangement of the letter buttons contemplates the relative frequency of occurrence of letters in the English language and maps that frequency onto the dexterity of the thumb and fingers. Thus, the vowels a,e,i, and o are accessed by combinations of the thumb and first finger that are the most dexterous digits.

The panel 112 compliments the typical word processing functions. The thumb origin for the panel 112 is at the bottom left hand corner of the "Period" button. This panel also operates on the basis of couplet chording. Thus the "Tab" button is accessed by the chord "T & 1 & 2" & "2". The "Shift" button is accessed by the chord "3 & 4" & "T". The "Numbers" and "Symbols" buttons are in the nature of pop-out menus giving access to, respectively, a numerical panel such as the panel 104 shown in Fig. 9 and other couplet panel arrays in respect of symbol sets.

It will be noted that each of the couplet chords contained within both of the panels 110,112 is unique from any other. The right-hand panel could be chorded by the user's other hand if a second input device were provided. The arrangement shown in Fig. 10 is well suited for word processing functions, and can enable touch typing much in the manner of a conventional qwerty keyboard with a minimum of tuition.

Fig. 11 shows a form of a virtual calculator 114. The calculator comprises a 3 x 3 couplet pad array 106 (as previously shown in Fig. 9), for which the thumb origin

is at the lower left hand corner of the "1" button. The calculator 114 also comprises a number of single cord buttons delineated from the couplet pad array 106 as shown by the dashed lines. The thumb origin for the chord buttons is the left hand side of the panel 116. The top window 118 represents an inner display to indicate the function of the calculator 114 much in the nature of a conventional hand-held calculator. The single chord required to activate any of the function buttons or "0" button are independent of the first chord of any couplet pertaining to the buttons within the pad array 106. By way of example, the number 643 is chorded by the sequence "1" & "2", "1" & "T" and "T" & "2". This number can be operated on, say to be multiplied by 2 by the successing chords: "4" then "T" & "1" then "T & 1 & 2 & 3 & 4".

Fig. 12 shows a display arrangement termed cross-chords. The thumb origin for the shaded buttons extending in the upper half of the display along the left hand side and horizontally across the mid-point of the display is illustrated as T_1. The thumb origin for the buttons arranged on the right hand side of the lower half of the display 50 is shown as T_2. Fig. 12 also shows the chord required to activate each button, from which it can be seen that each chord is mutually exclusive from any other.

Fig. 13 shows an alternative representation of an indicium 130. The convention in this case is that because only the four vertices of the rectangular box are displayed, then the thumb always forms a part of the chord. Accepting the further convention of the bottom left-hand vertice being the origin, then the chord would be formed by the combination "T & 3 & 4". The dot chord representation also is shown.

Fig. 14 shows an example of the combination of two indicia 132,134 forming bar chords and couplets. The two possible bar chords have their dot chord value superimposed on them, and respectively are formed by "T" and "1 & 2 & 3 & 4". The second indicium 134 also can be utilised in the form of a couplet in conjunction with the indicia 136-144 for the five bar chords superimposed on it. Note too that the dot chord representation corresponding to each chord has been shown. To activate the middle indicium 140 on the background indicium 134, the couplet chording sequence is "1 & 2 & 3 & 4" and "3".

Fig. 15a and 15b show an alternative representation for couplet chording for a number of indicia 150-156. Also shown is the corresponding dot chord representation. The convention adopted is that horizontal takes precedence over vertical, thus in the case of Fig. 15a leading to the couplet "4" and "4", and for Fig. 15b "3 & 4" and "T & 4".

Fig. 16a shows an abbreviated form of an indicium 160 representing three bar chords. The two tabs 162,164 located along the bottom edge of the indicium 160 indicate that "T & 1" are required to access any one of the three superimposed sub-indicia 166-170. The dot chord representation for those three sub-indicia 166-170 also are shown. In Fig. 16b, the tabs 182, 184 are located to the right hand side of the indicium 180, indicating the keys "3 & 4" are required as well as the corresponding key of the superimposed sub-indicia 186-190 to effect a chord.

A library of conventions can be chosen, and as follows from the example presented herein, it is apparent that the left hand side and/or bottom of an indicium represents the thumb origin. The thumb is always the starting point - this is particularly important if less than five keys are provided. Horizontal takes precedence over vertical as does clockwise over anticlockwise. All indicium must satisfy the rule that they are resolvable into a 'press path'.

Embodiments of the present invention have immediate application in relation to conventionally-understood computing devices, but equally could be incorporated into viewfinder control systems (e.g. camcorders), autotellers, fax and photocopy machines, embedded interfaces (e.g. vending machine maintenance interfaces), mobile telephones and pagers, portable machinery (e.g. service equipment), video and television remote controllers, interactive television controllers, personal stereos, household appliances (e.g. clock radios), vehicleonics (e.g. air conditioning, cruise control, stereo, cabin controls, etc.), powertool interfaces (e.g. pistol grip-style drills) control mounted (e.g. steering wheel or joystick), game and toy interfaces, electronic slate-style magazines, pocket organisers, hand-held computing devices, notebook and pen computers.

A particular advantage accrues by virtue of the present invention in that the indicia can be easily scaled and yet retain the information content thereof. This is in contrast conventional windowing-type systems, where icons, if they were able to be shrunk, would lose their information content, and also would become difficult to access by means of a pointing device. Indeed, prior art windowing systems do not have provision for the scaling of a "window" or icons within a window, rather simply collapse the window itself. By the use of indicia in accordance with the present invention, no such pointing is required, rather the information content will be retained so long as the eye can resolve an indicium, of course depending also upon the pixel resolution of the display device. This means that a greater number of indicia can be included on a display than for the conventional windowing systems.

Figs. 17a-17c show a display on which a pictorial representation, in this case being of a woman, is shown. The display equally could be of a map or an integrated circuit layout, for example. The display 50 shows the 5 x 5 array of regions occupying the whole of the display. Utilising the couplet chording principle discussed earlier, a segmenting cursor or "zoom" function can be achieved.

The thumb origin is located at the bottom left hand corner of the display 50, and in the examples shown, the first chord of the couplet is "2" that results in the highlighted representation shown in Fig. 17b. On activation of the other half of the couplet chord "3", that particular chorded button is exploded and occupies the whole of the display 50 as shown in Fig. 17c. By further couplet chording, yet greater resolved detail can be obtained.

Figs. 18a and 18b show a variation of a segmented display, being a pointing function. By keying the couplet chord "3" & "2", that particular button has a further segmented array superimposed on it. A further chorded couplet can yet further divide one of the buttons within the highlighted button to point more specifically resolved on an object displayed.

Fig. 19 shows a mechanical arrangement for the input device 10. The body 11 is sized to fit into the palm of the hand of a user, and in the configuration shown is

suited to use by the left hand. The thumb therefore wraps around the side of the body 11 whilst the four fingers wrap across the top. The digits therefore can activate the keys in a manner previously described. Such an arrangement provides the advantage of being useable in a mobile configuration. The body 11 is securely grasped in the palm of the hand, and the digits do not have to move other than in a gross closing motion to activate the keys. The configuration shown is easily adapted for use by the right hand simply by flipping it over, therefore is completely ambidextrous.

Figs. 20a and 20b show an alternative arrangement for an input device 10'. The hand-held device 10' comprises two body portions 12,13 hingedly connected together. The arrangement of the keys with respect to each of the body parts 12,13 is shown.

The particular advantage of this configuration is that it is ambidextrous, and also can be used either in the manner shown for the controller 10 of Fig. 19 when grasped in the palm of the hand, in which case the respective body parts 12,13 are arranged at an acute angle to each other, or with the body parts in a common plane for use as an on-bench keyboard.

Fig. 21 shows a conventional qwerty keyboard layout. A further embodiment of the invention provides for combined chording/qwerty operation by means of such a conventional qwerty keyboard. Thus the keyboard shown in Fig. 21 can be operated in the usual manner, however the software resident on the associated processing device can recognise when chords are keyed in distinction to single key presses for conventional inputs. In the embodiment, the "home" keys and the space bar are used as the keys for chording operation. If the right hand is being used for chording, then the sequence of qwerty keyboard keys corresponding to the sequence of the digits commencing with the thumb is: "space bar, J,K,L,;". If the left hand is being used for chording, then the chording keys are: "space bar, F,D,S,A". In operation of software embodying this concept, the display presented to the user can be, say, a conventional word processing package, with superimposed chording indicia. The only restriction is that the so-called "singleton" chords (i.e. the single digit presses) that are excluded.

It would be readily apparent to one skilled in programming arts how to write code to implement the embodiments of the invention hereinbefore described without the exercise of any inventive faculty. In this connection Figs. 22 to 24 are included that respectively are flow diagrams of the chording methodology, the couplet methodology and the chord/qwerty methodology. In Fig. 22 step 200 detects a key press. If, in step 202, a chord is to be formed on release, then step 204 checks to determine whether all the keys are depressed, and if so step 206 sends the value of the chord keyed. If the chord is not to be formed on release, step 208 delays sending of the chord keyed.

Fig. 23 concerns the extension of Fig. 22 to the forming of couplets. Step 210 represents waiting for a chord press, and once such is received, step 212 determines whether the chord pressed is part of the present couplet. If not, there is a return to step 210. If the result of step 212 is yes, then step 214 tests whether for the present couplet the second part is being awaited. If no, step 216 determines whether it is the first part, and if no again, step 218 ignores the chord and returns to step 210 to await a further chord, If, however, it is the first part of the chord, then step 220 sets the "waiting" flag and returns to step 210. In step 214, if yes, step 220 determines whether the chord is the second part, and if not loops to step 210, but if so, step 222 clears the "waiting" flag and forwards the couplet press.

Fig. 24 represents the combined chording/qwerty operation. Step 230 awaits the next press, and on receipt of such tests whether chording is allowed in step 232. If no, the key press is forwarded for its qwerty value by step 234. If chording is allowed, then step 236 determines whether the value is for a chord key (i.e. the home keys as described). If not, step 238 determines whether operation is for chording only, and if so, step 240 therefore ignores the key press, and otherwise the key pressed value is forwarded in step 242 for its usual qwerty value. If, in step 236, the key press value is for a chord, step 242 forms the chord. There then follows a determination in step 242 of whether the chord is a singleton chord, and if not, step 244 sends the chord pressed value, but if so, step 246 determines whether singleton chords are allowable, and if not,

step 248 forwards the nominal qwerty key value. If singletons are allowed, then step 250 sends the chord pressed value.

The following coding is included for illustrative purposes, and is consistent with the flow diagrams of Figs. 22 to 24. The coding is written to run on the program ToolBook (TM) version 3.0, which is a Windows (TM)-based multi-media authoring tool published by Asymetrix Corporation of the United States. The code is commented, as indicated by the prefix "--".

```
to set KSQwertyOn to offOn          --allow external objects to change KordOS
system QwertyOn                     --internal settings
set QwertyOn to offOn               --this setting allows normal KBD
end

to set KSremainderOn to offOn
system remainderOn                  --allows non-chordal KBD presses
set remainderOn to offOn
end

to set KSChordingOn to offOn
system ChordingOn                   --Chording master on/off switch
set ChordingOn to offOn
end

to set KSQwertyOnly to offOn
system QwertyOnly                   --locks out chords
set QwertyOnly to offOn
end

to set KSPressReleaseType to Pval
system pressReleaseType             --chord formed instantly or on release
set PressReleaseType to Pval
end

to handle Keydown vkey              --handle the ToolBook (TBK) message
                                    --message Keydown ie. a KBD key

system remainderOn                  --declare system vars for this handler
system QwertyOn
system QwertyOnly
system ChordingOn
system pressRelease Type
```

```
get ChordingOn                          --check if on, skip if not
if it = "false" then
forward
break
end

system chordList[31]                    --initialise left & right hands
RT = keyspace
R1 = keyj
R2 = keyk
R3 = keyl
R4 = keysemicolon
LT = keyspace
L1 = keyf
L2 = keyd
L3 = keys
L4 = keya

vvkey = lowercase(vkey)                 --filter upper case of message parameter

if vvkey = RT or VVkey = R1 or VVkey = R2 or vvkey = R3 or vvkey = R4\
or vvkey = LT or vvkey = L1 or vvkey = L2 or vvkey = L3 or vvkey = L4 then
                                        --check if its a Kording key on KBD

set chord to 0                          --reset local variables
set thumbPressed to false
set firstPressed to false
set secondPressed to false
set thirdPressed to false
set fourthPressed to false

if pressReleaseType = "WaitForRelease" then     --check how the chord is made
        do
        if keyState(RT) is "down" or keystate(LT) is "down"  --keyState() is aTBK
        func'n
        set thumbPressed to true
        end
        if keyState(R1) is "down" or keystate(L1) is "down"
        set firstPressed to true
        end
        if keyState(R2) is "down" or keystate(L2) is "down"
        set secondPressed to true
        end
        if keyState(R3) is "down" or keystate(L3) is "down"
        set thirdPressed to true
        end
        if keyState(R4) is "down" or keystate(L4) is "down"
        set fourthPressed to true
```

```
            end
            until keyState(RT) is "up" and keyState(R1) is "up"\
            and keyState(R2) is "up" and keyState(R3) is "up"\
            and keyState(R4) is "up"

    if qwertyon = 'false'                    --
    get flushmessagequeue()                  --clear the KBD buffer
    end
    end

    if pressReleaseType = "instant" then     --the other way of chording
            pause 15                         --debounce other keys
            if keyState(RT) is "down" or keystate(LT) is "down"
            set thumbPressed to true
            end
            if keyState(R1) is "down" or keystate(L1) is "down"
            set firstPressed to true
            end
            if keyState(R2) is "down" or keystate(L2) is "down"
            set secondPressed to true
            end
            if keyState(R3) is "down" or keystate(L3) is "down"
            set thirdPressed to true
            end
            if keyState(R4) is "down" or keystate(L4) is "down"
            set fourthPressed to true
            end
    if qwertyon = "false"
    get flushmessagequeue()
    end
    end

    if fourthPressed is true                 --build raw chord value
    set chord to 1
    end
    if thirdPressed is true
    chord = chord + 2
    end
    if secondPressed is true
    chord = chord + 4
    end
    if firstPressed is true
    chord = chord + 8
    end
    if thumbPressed is true
    chord = chord + 16
    end
```

```
    if chord = O then                          --internal error trap
    get flushmessagequeue()
    break
    end

    if qwertyon = 'true' then                  --forward singleton chords
            if chord = 1 or chord = 2 or chord = 4 or chord = 8 or chord = 16 then
            forward
            break
            end
    end

    get flushMessagequeue()                    --clear KBD buffer
    chordval = chordlist[chord]                --look up the content of raw chord
    send kordPressed chordval to this Page     --send message to graphic Page
                                               --a TBK structure
                                               --page forwards message to all
                                               --objects on it
    else                                   --end of test for non-finger chars
                                           --below we handle     "       "
    if remainderOn = "true" then           --they want all non-chord values
    forward
    else
    get flushMessagequeue()                    --another obsessive clear
    end
    end
    end

    to handle enterbook                --initialise this system book on startup
    send resetKords                    --sends message resetKords
    end

    to handle resetKords               --set the raw chord contents
    --put otherChords = "     "here
    Handchords =
    "1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,25,27,28,29,30,
    31"

    dotChords =
    "....|,...|.,...||,..|..,..|.|,..||.,..|||,.|...,.|..|,.|.|.,.|.||,.||..,.||.|,.|||.,.||||,|....,|...|,|..|.,|..||,|.|..,|.|.|,|.||.,
    |.|||,||...,||..|,||.|.,||.||,|||..,|||.|,|||.,|||||"

    system chordList[31]
    fill chordlist with handChords in [item] order

    system remainderOn                 --declare system vars for this handler
    system QwertyOn
    system QwertyOnly
```

```
system ChordingOn
system PressReleaseType

set qwertyOn to "false"              --reset to known state
set remainderOn to "true"
set QwertyOnly to "false"
set ChordingOn to "true"
set PressReleaseType to "WaitForRelease"
end

--this is a typical button handler, it receives the message from the page
--this script is contained
to handle Kordpressed kordval
if kordval = myKordVal of self       --check the parameter of the message
                                     --my predefined attribute, ie. is it me?

--**** perform some action

end
end

to handle buttonClick                --allows mouse clicks
send Kordpressed myKordVal to self   --trick me that a key is pressed
end
```

Emboiments of the present invention have industrial applicability at least in terms of rendering useful computing devices adapted for portability or use in adverse high motion environments.

CLAIMS:

1. A computing device having a human/machine interface comprising:

an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits;

a visual display device; and

a processor device receiving instructions or data from the input device and outputting information to the display device, the processor device being programmed to cause the visual display of indicia, and wherein each indicium represents a user initiated instruction or data input and is displayed in one-to-one correspondence with the sequential relation of one or more of the keys.

2. A computing device as claimed in claim 1, wherein, in use the computing device, a user temporally notionally partitions the visual display of the display device into a plurality of non-overlapping regions, each region corresponding to one of the digits, and the regions being in the same sequential relation as the digits, and whereby any one or more regions intersected by an indicium corresponds to the combination of keys that give effect to the instruction or data input represented by the indicium.

3. A computing device as claimed in claim 2, wherein the indicia and the regions are arranged orthogonally.

4. A computing device as claimed in any one of the preceding claims, wherein there are five keys.

5. A computing device as claimed in any one of the preceding claims, wherein some of the user initiated instructions or data inputs correspond to at least two discrete combinations of keys.

6. A human/machine interface program for implementation on a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits, a visual display device and a processor device to give effect to the program, the program comprising:

an input element to receive instructions or data from the input device;

an output element to pass display information to the display device; and

a processing element, coupled to the input element and the output element, to cause the display of indicia, and wherein each indicium represents user initiated instructions or data and is displayed in one-to-one correspondence with the sequential relation of one or more of the keys.

7. An interface programme as claimed in claim 6, wherein some of the user initiated instructions or data inputs correspond to at least two discrete combinations of keys.

8. A method for implementing a human/machine interface for a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation of the digits, and a visual display device; the method comprising the step, implemented on processor means, of:

visually displaying indicia on the display device, each indicium being in one-to-one correspondence with the sequential relation of one or more of the keys, thereby to allow input of an instruction or data represented by each indicium by the respective one or more keys.

9. A method as claimed in claim 8, wherein, in practice of the method, a user performs the steps of:

notional partitioning the visual display device into a plurality of non-overlapping regions, each region corresponding to a key and being arranged with the same sequential relation as the digits; and

activating the one or more keys corresponding to the one or more regions intersected by an indicium to give effect to the instruction or data input represented by the indicium.

10. A method as claimed in claim 8 or claim 9, wherein two extra indicia are displayed, each extra indicium corresponding to a shifted state of the user's thumb to provide for implementation or further instructions or data inputs.

11. A method for implementing a human/machine interface for a computing device, the computing device including an input device having a plurality of keys each corresponding to a separate digit of the human hand, the keys being arranged to match the relative sequential relation to the digits, and a visual display device; the method comprising the step, implemented on processor means, of:

displaying a regular array of indicia on the display device, each row and column of the array respectively being in correspondence, in an orthogonal manner, with the sequential relation of one or more of the keys, and each indicium corresponding to a sequence of a row and a column key, thereby to allow input of an instruction or data represented by each indicium by the respective sequence of keys.

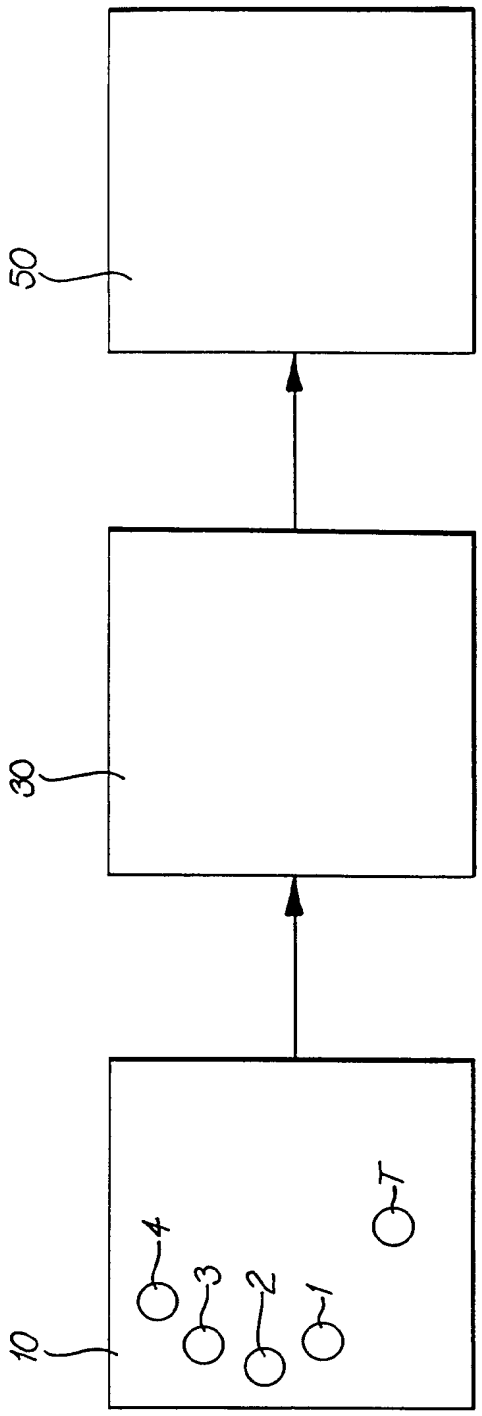

FIG. 1a

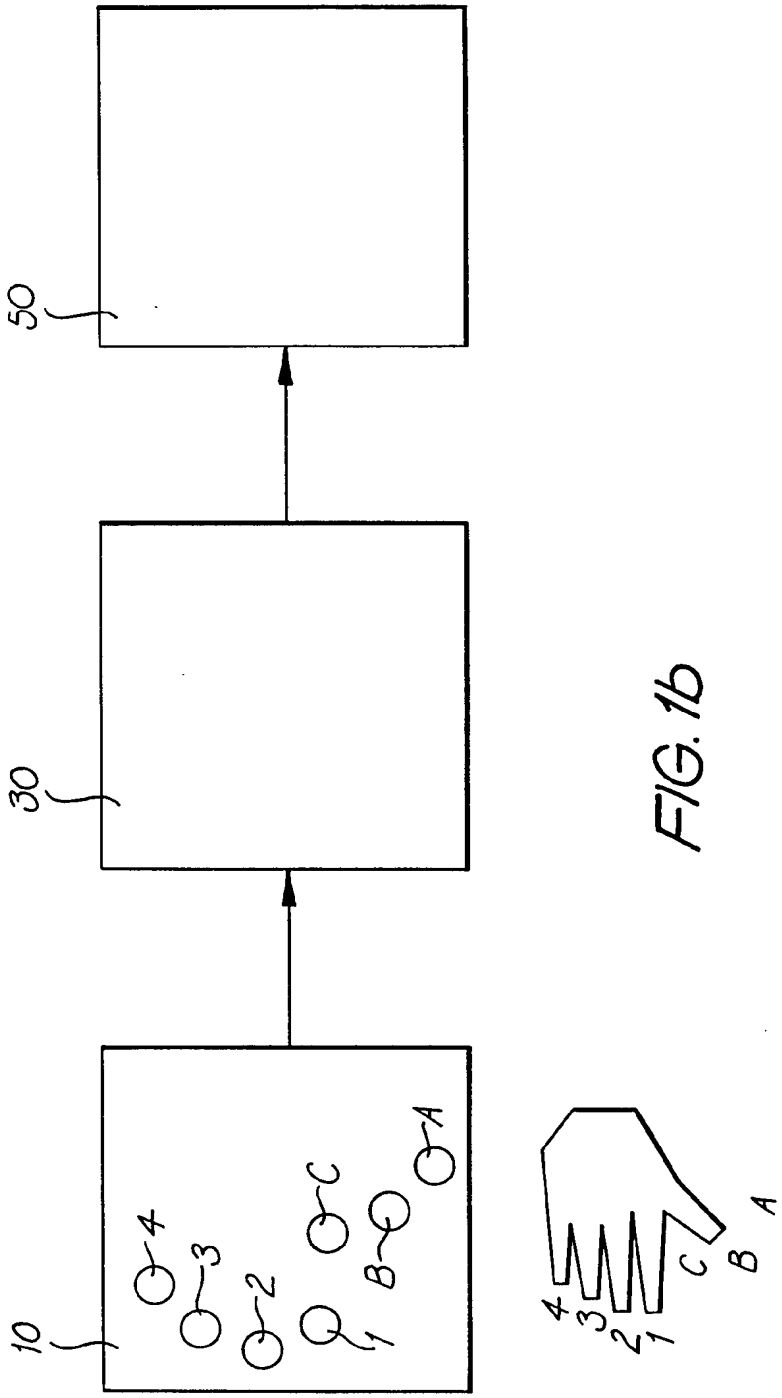

FIG. 1b

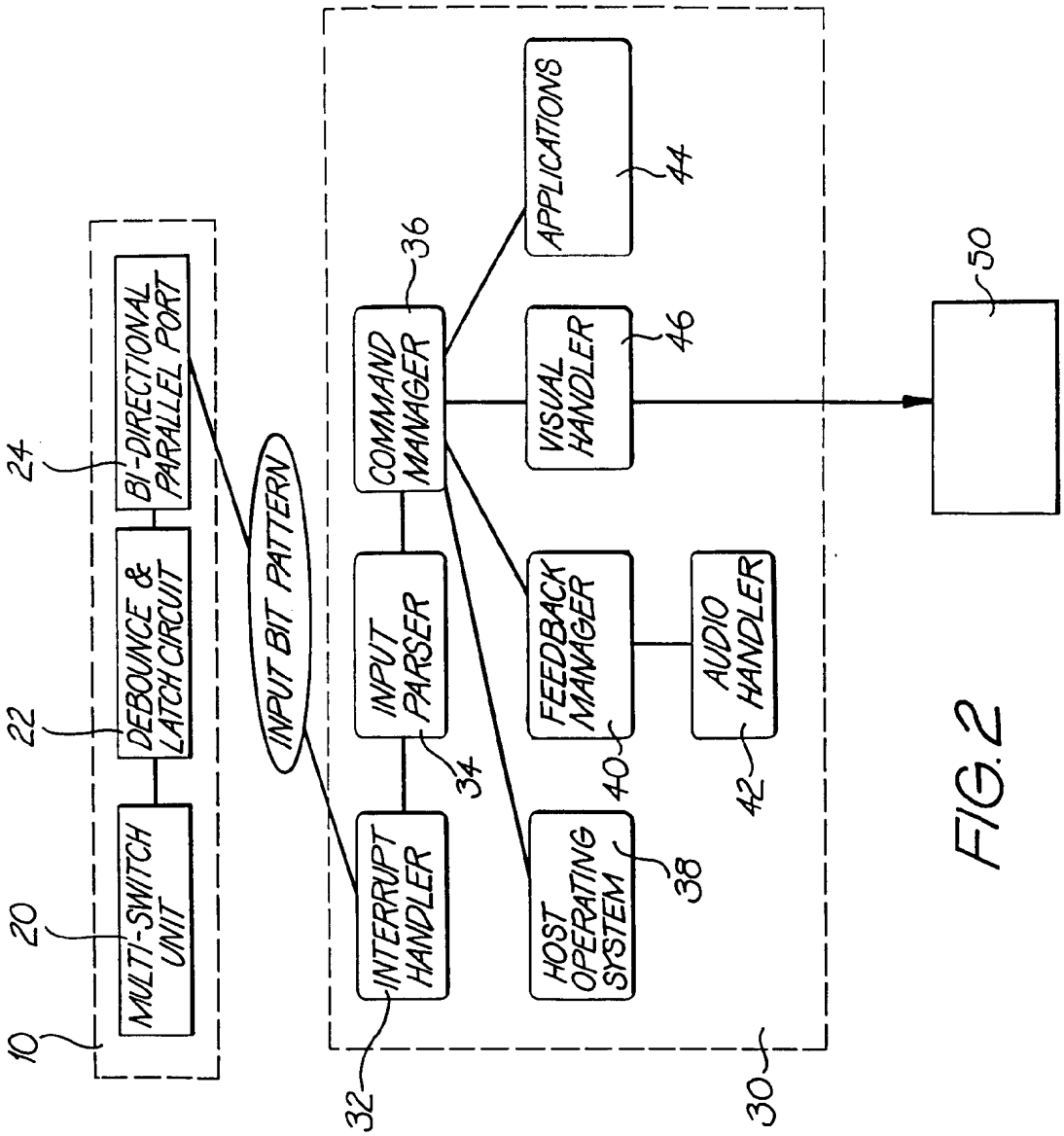
10
20
MULTI-SWITCH UNIT
22
DEBOUNCE & LATCH CIRCUIT
24
BI-DIRECTIONAL PARALLEL PORT
INPUT BIT PATTERN
32
INTERRUPT HANDLER
34
INPUT PARSER
36
COMMAND MANAGER
30
HOST OPERATING SYSTEM
38
FEEDBACK MANAGER
40
AUDIO HANDLER
42
APPLICATIONS
44
VISUAL HANDLER
46
50

FIG.2

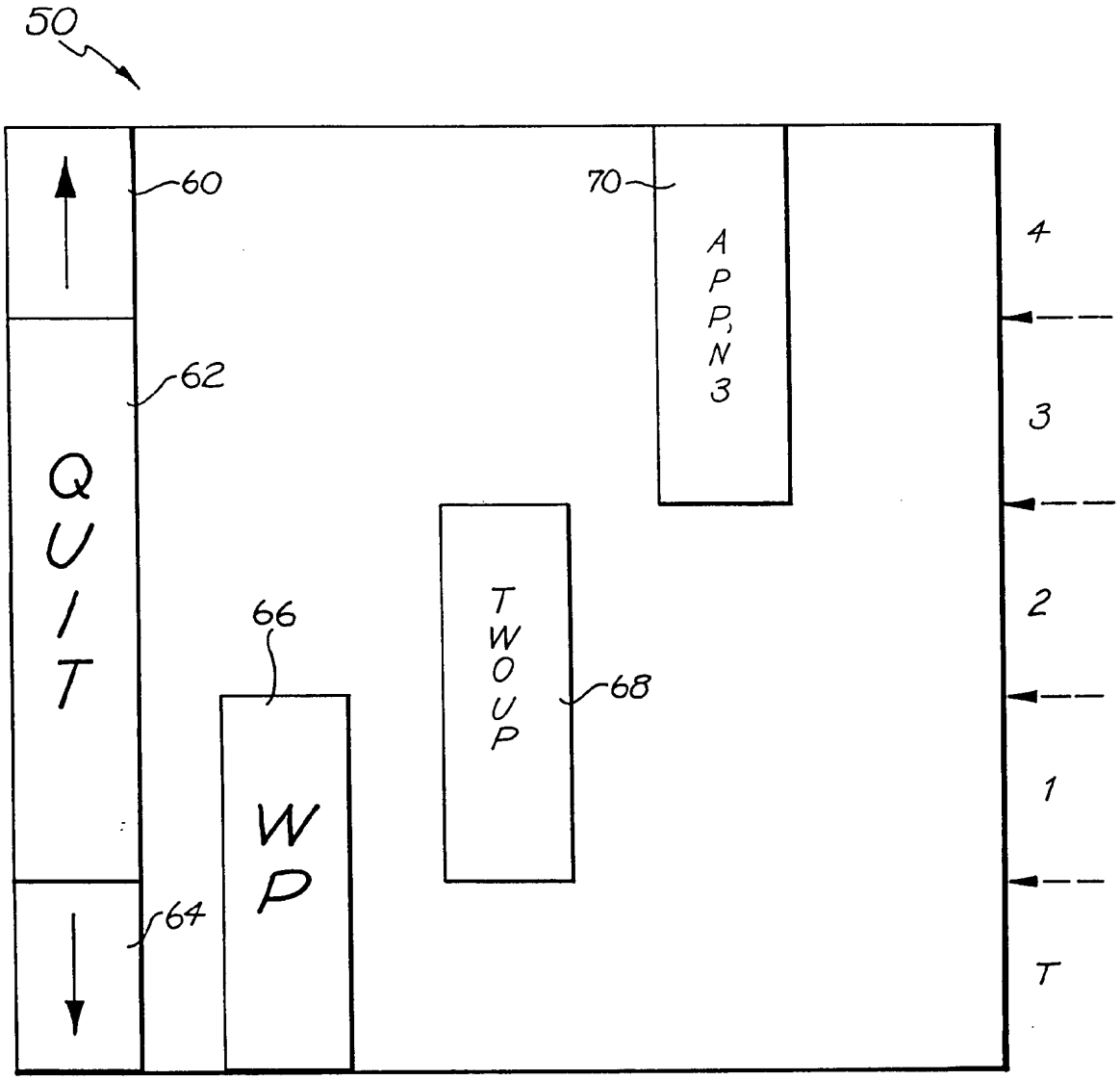

FIG. 3

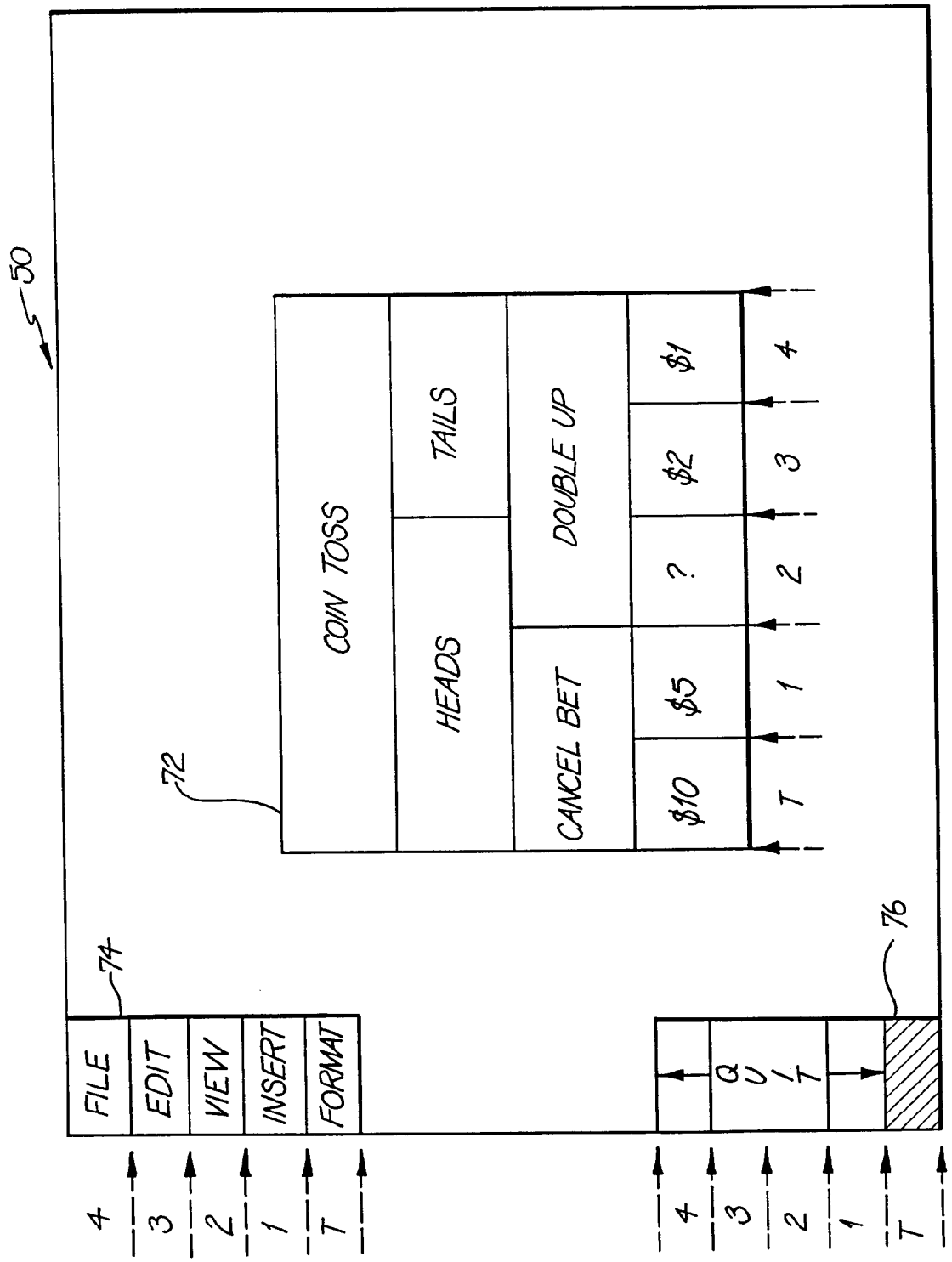
50
72
COIN TOSS
HEADS
TAILS
CANCEL BET
DOUBLE UP
$10
$5
?
$2
$1
T
1
2
3
4
74
FILE
EDIT
VIEW
INSERT
FORMAT
76
QUIT
4
3
2
1
T

FIG.4

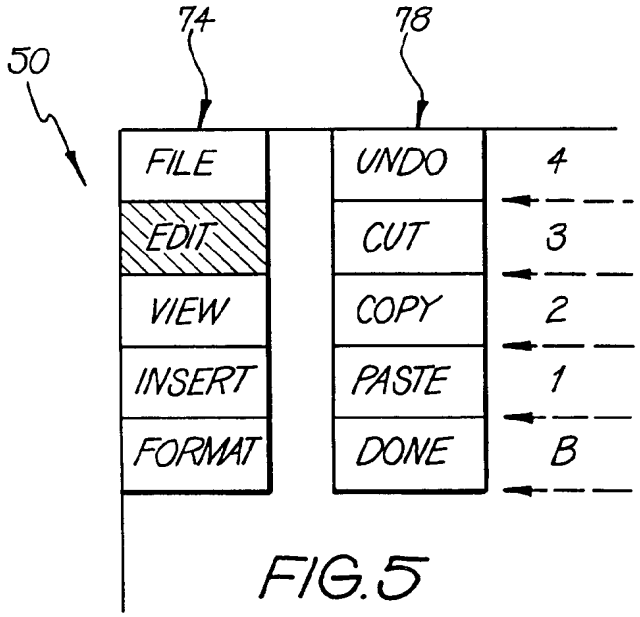
50
74
78
FILE
EDIT
VIEW
INSERT
FORMAT
UNDO
CUT
COPY
PASTE
DONE
4
3
2
1
B

FIG.5

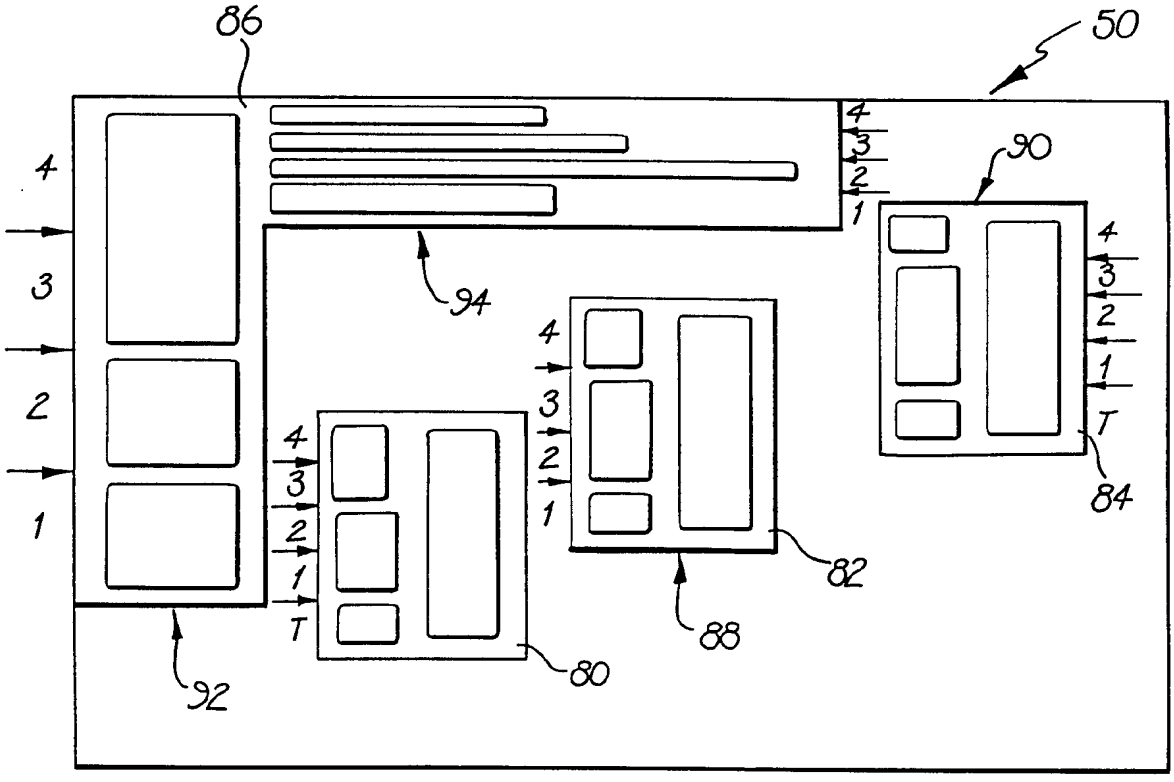
86
50
90
94
92
80
82
84
88
4
3
2
1
T
B

FIG.6

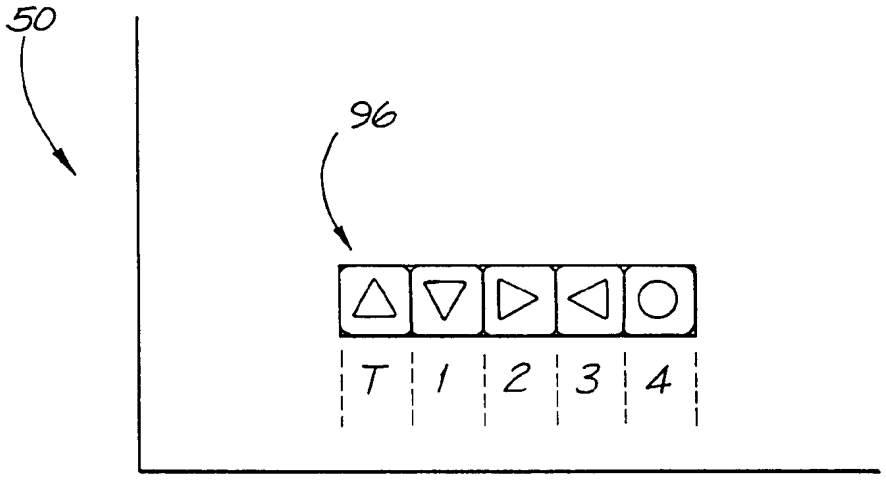

FIG. 7a

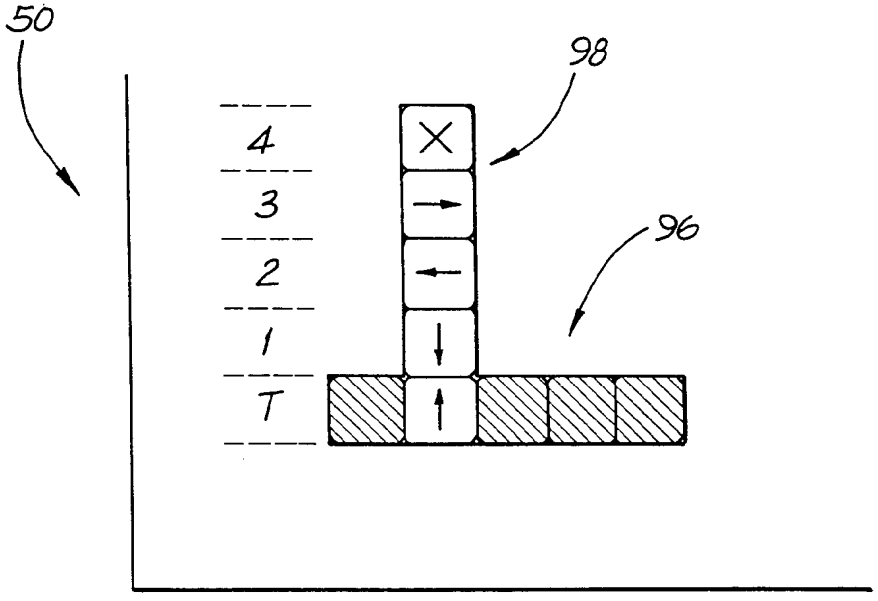

FIG. 7b

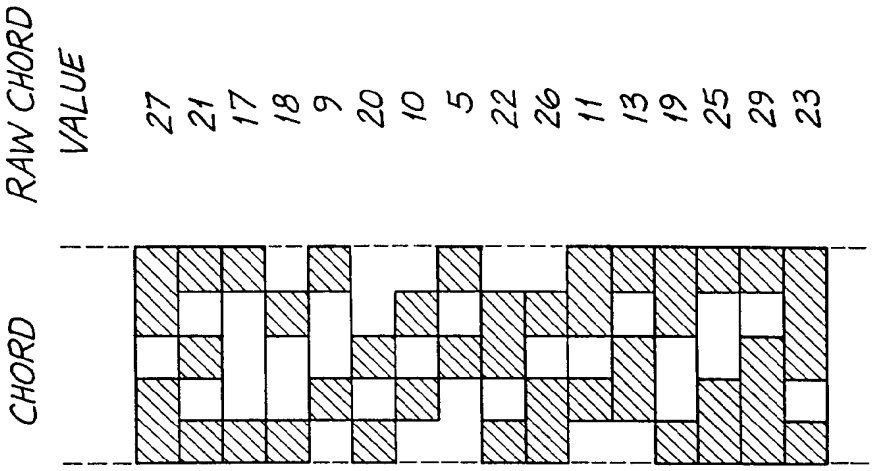
RAW CHORD VALUE
27 21 17 18 9 20 10 5 22 26 11 13 19 25 29 23
CHORD

FIG. 8b

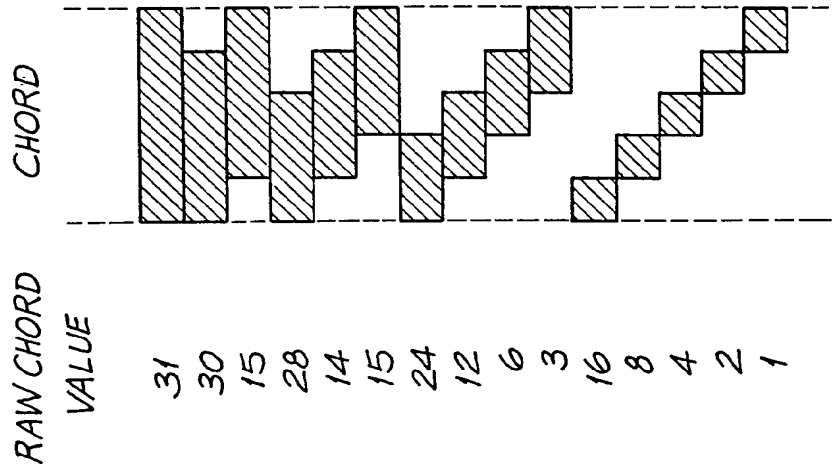
CHORD
RAW CHORD VALUE
31 30 15 28 14 15 24 12 6 3 16 8 4 2 1

FIG. 8a

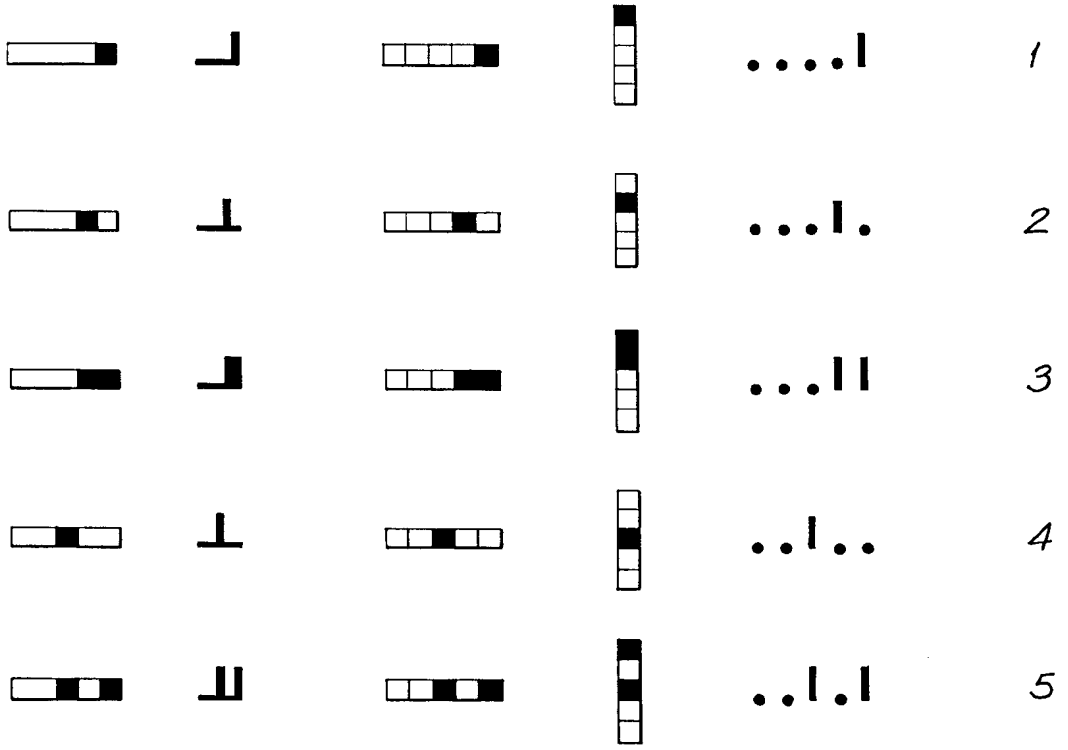
....1 1
...1. 2
...11 3
..1.. 4
..1.1 5

FIG. 8c

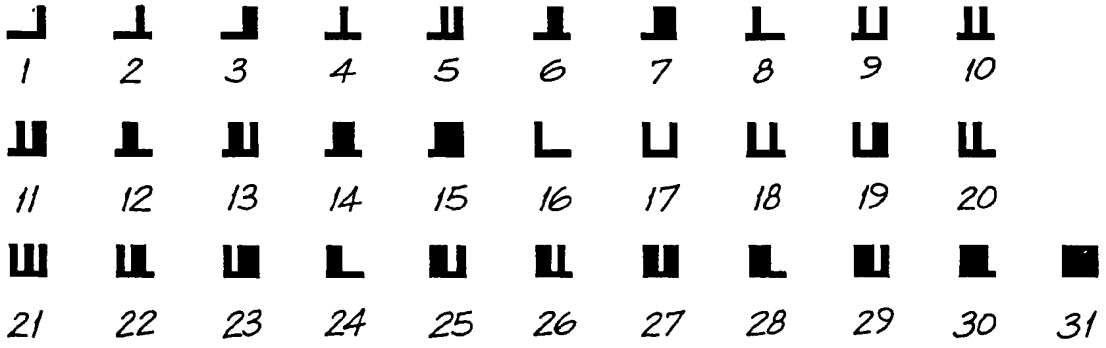
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30 31

FIG. 8d

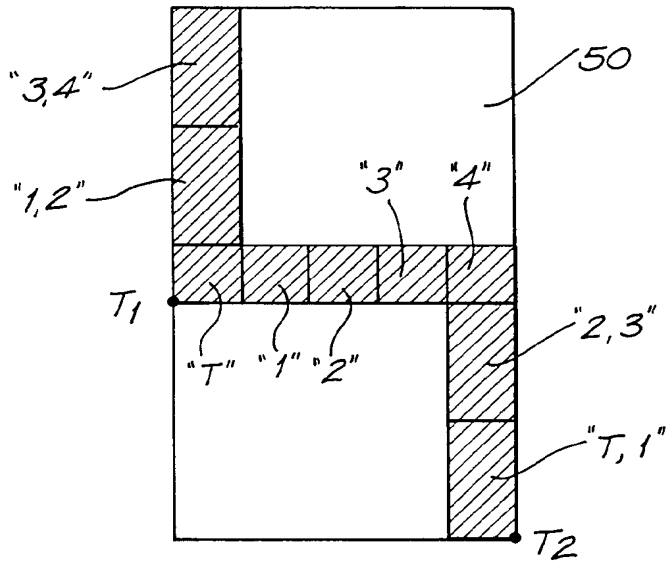

FIG. 12

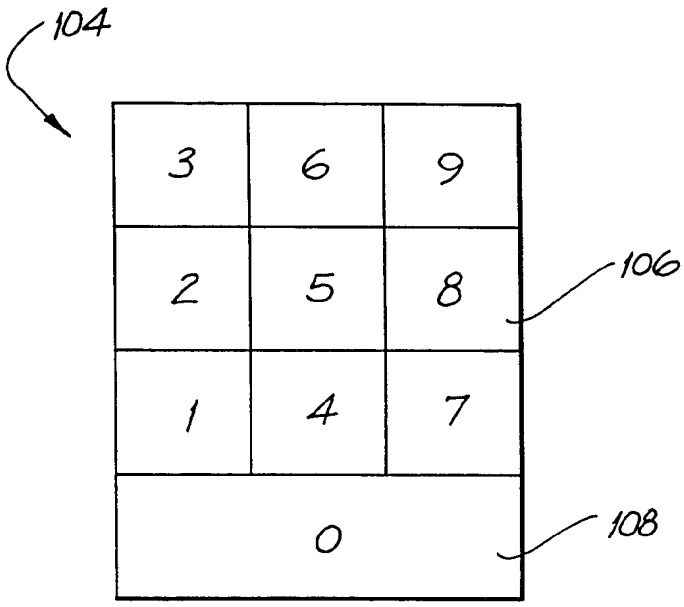

FIG. 9

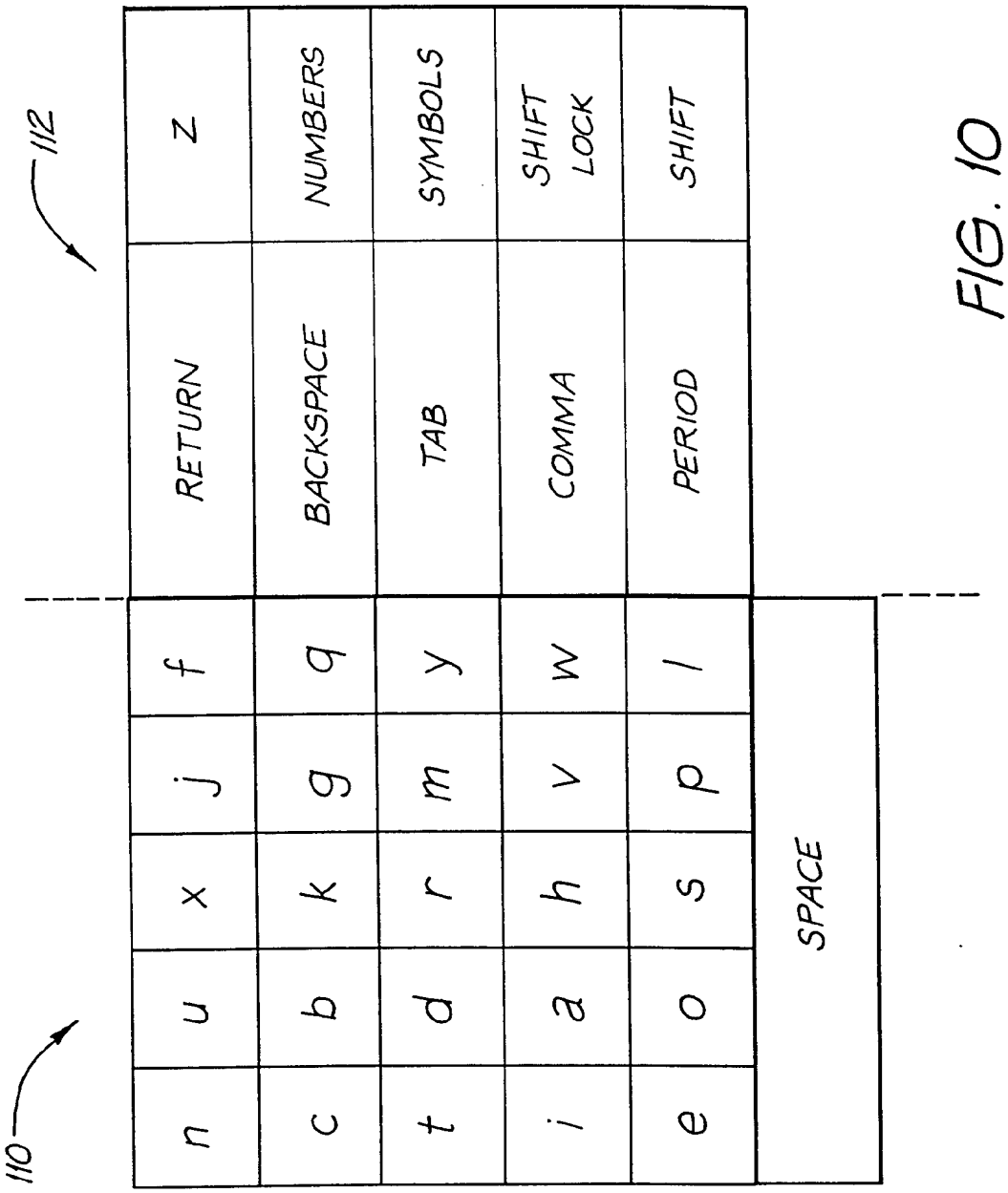
112
110
n u x j f
c b k g q
t d r m y
i a h v w
e o s p l
RETURN
BACKSPACE
TAB
COMMA
PERIOD
SPACE
Z
NUMBERS
SYMBOLS
SHIFT LOCK
SHIFT

FIG. 10

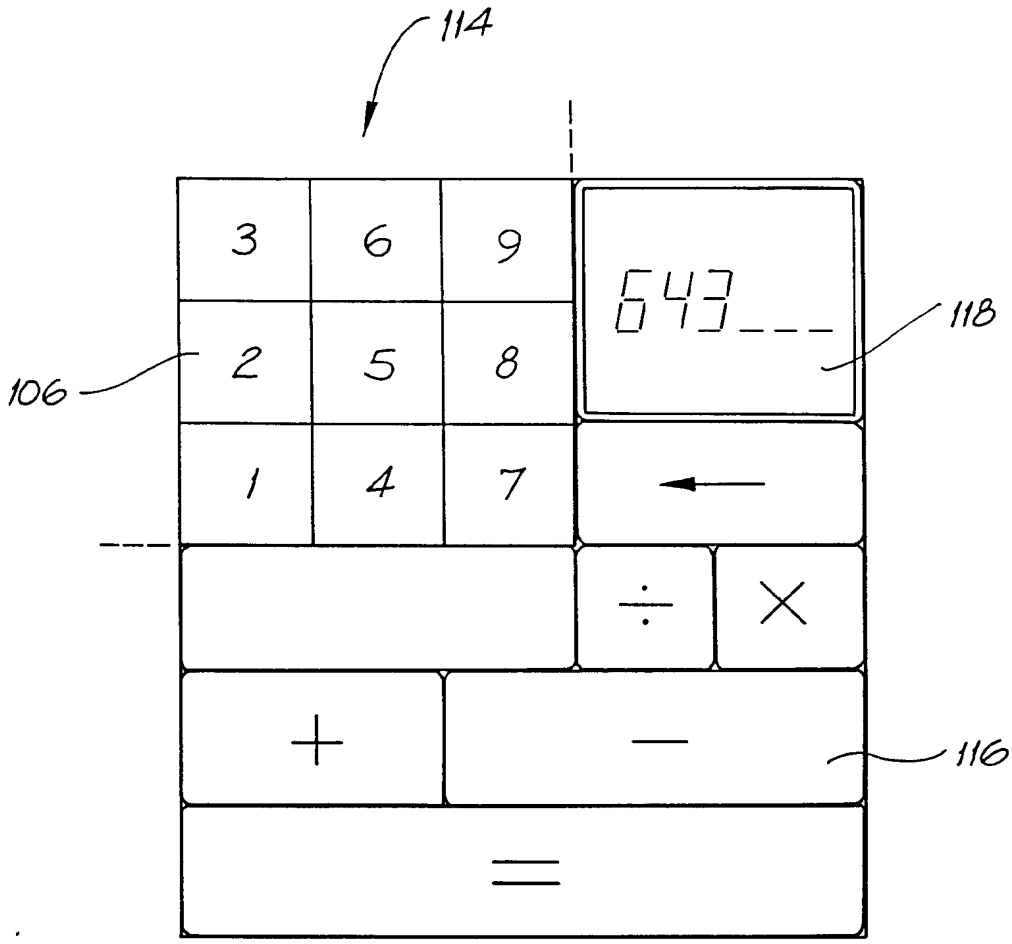

FIG. 11

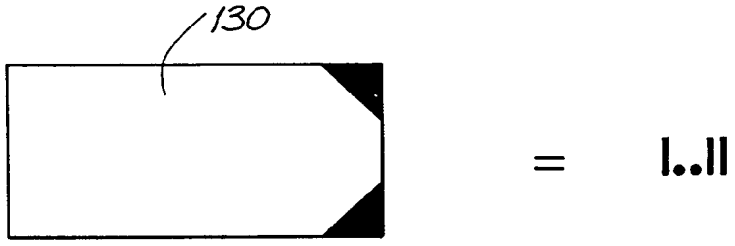

FIG. 13

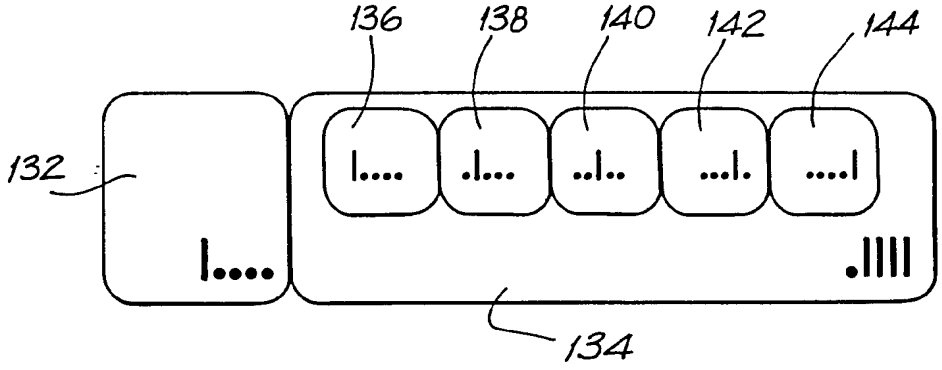

FIG. 14

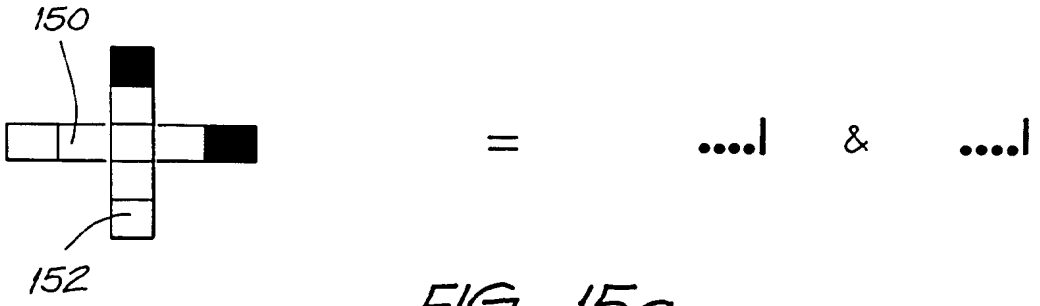

FIG. 15a

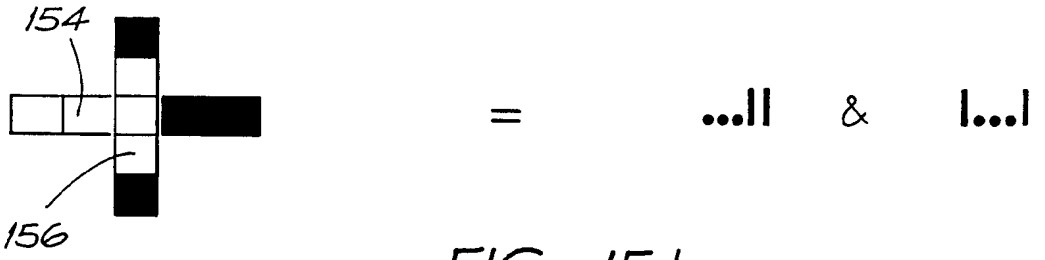

FIG. 15b

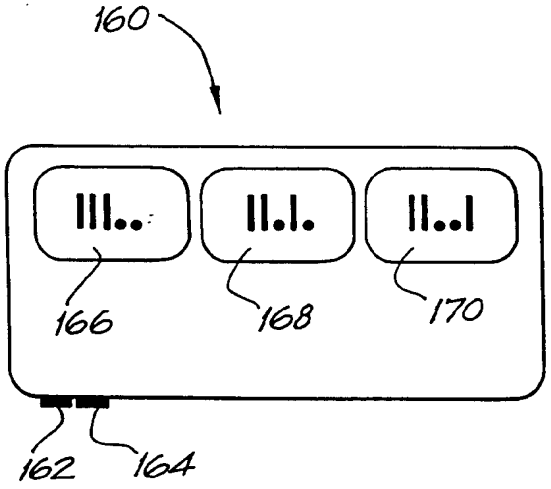

FIG. 16a

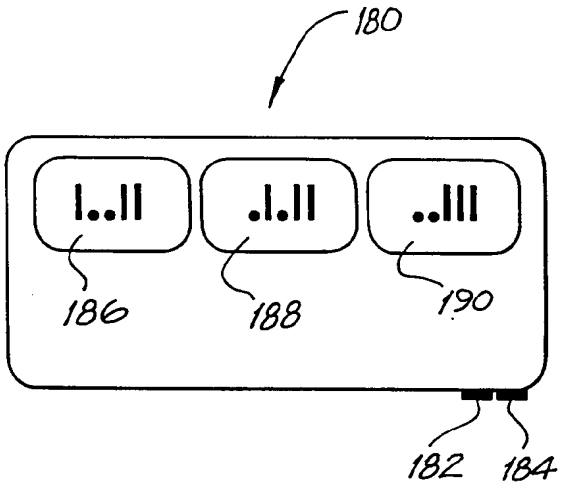

FIG. 16b

FIG. 17a

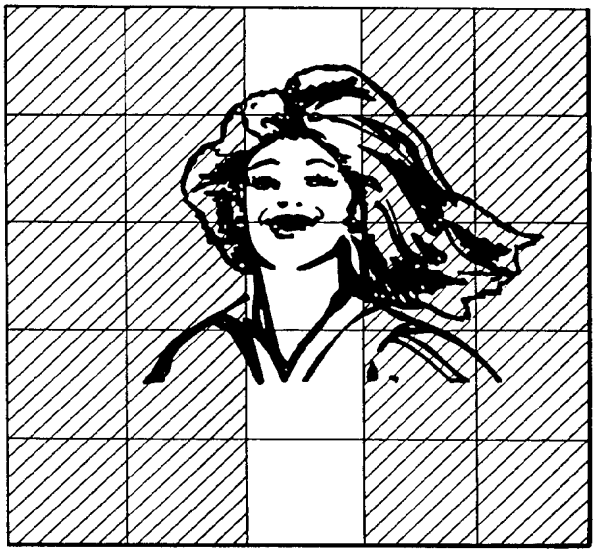

FIG. 17b

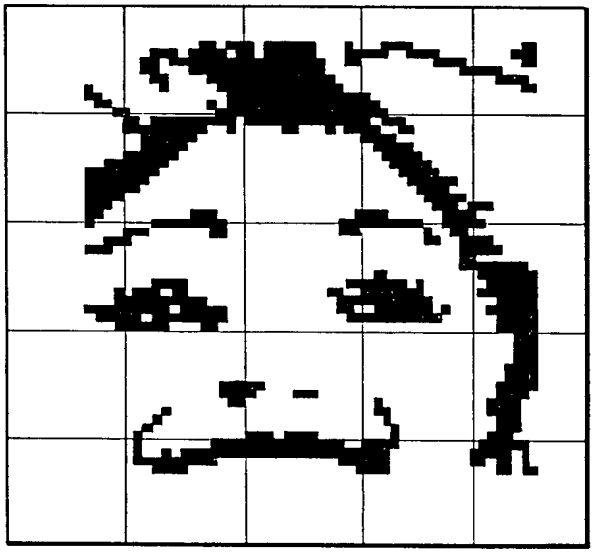

FIG. 17c

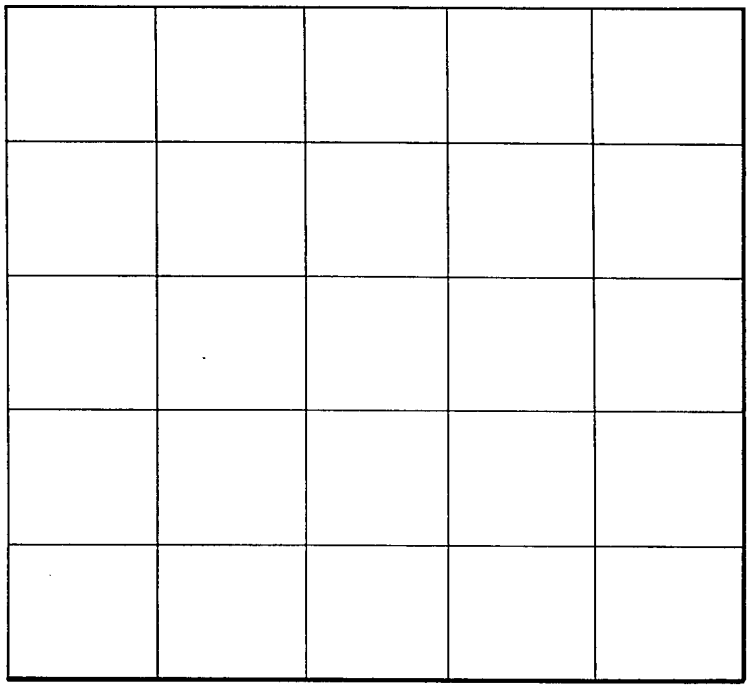

FIG. 18a

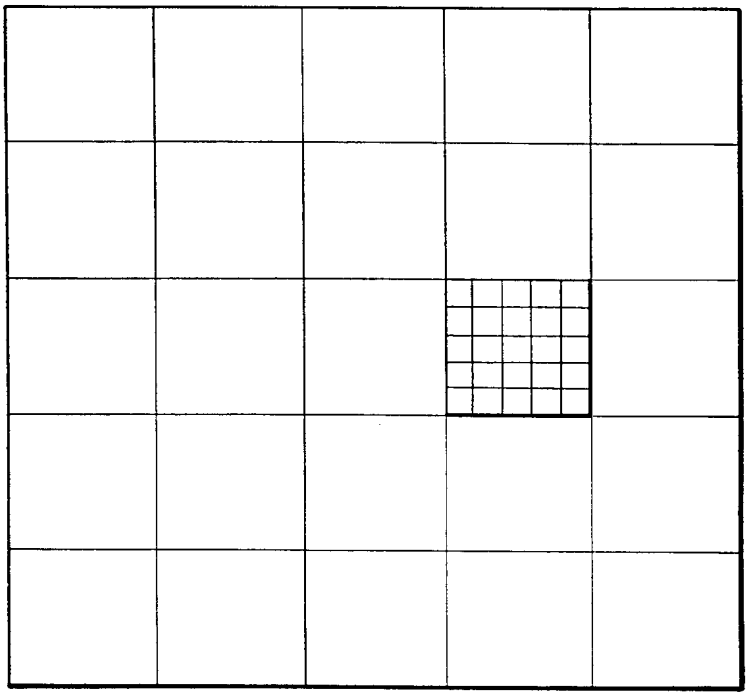

FIG. 18b

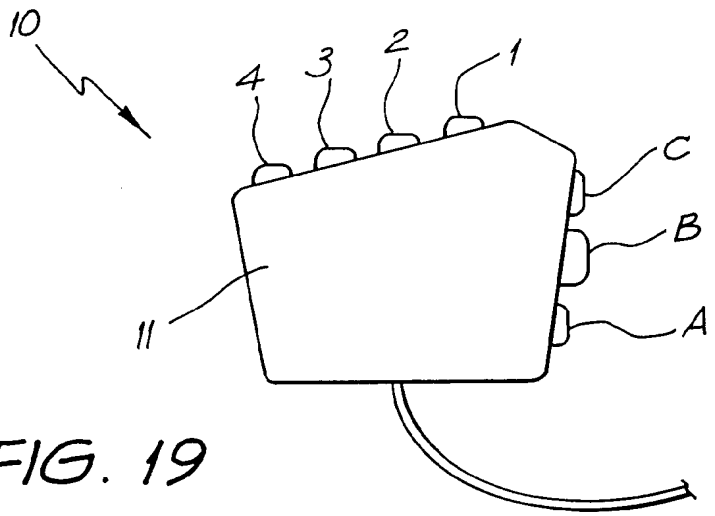

FIG. 19

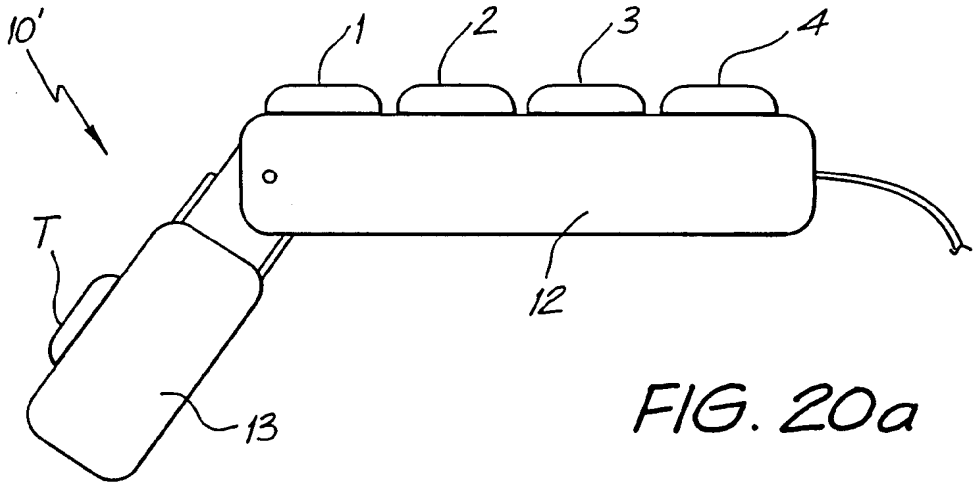

FIG. 20a

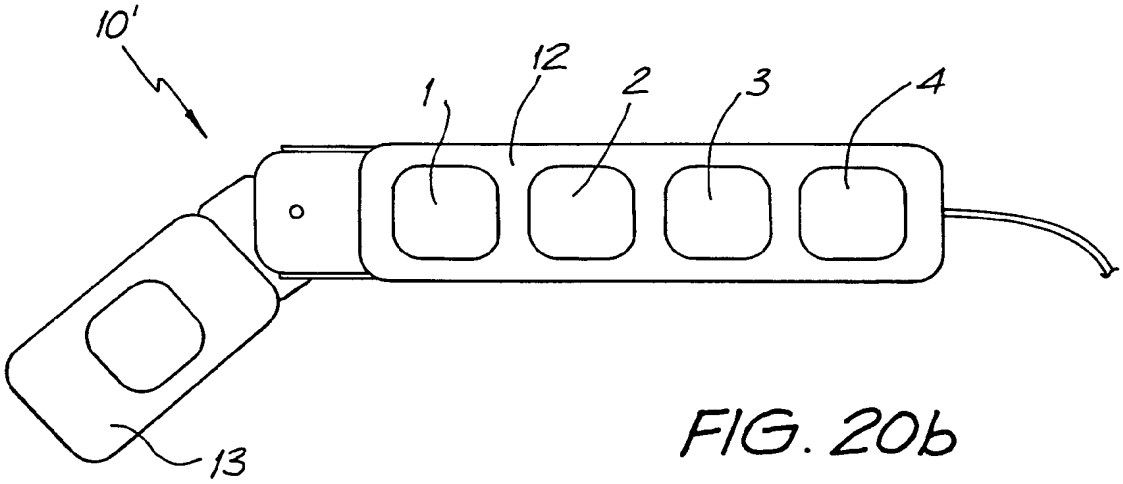

FIG. 20b

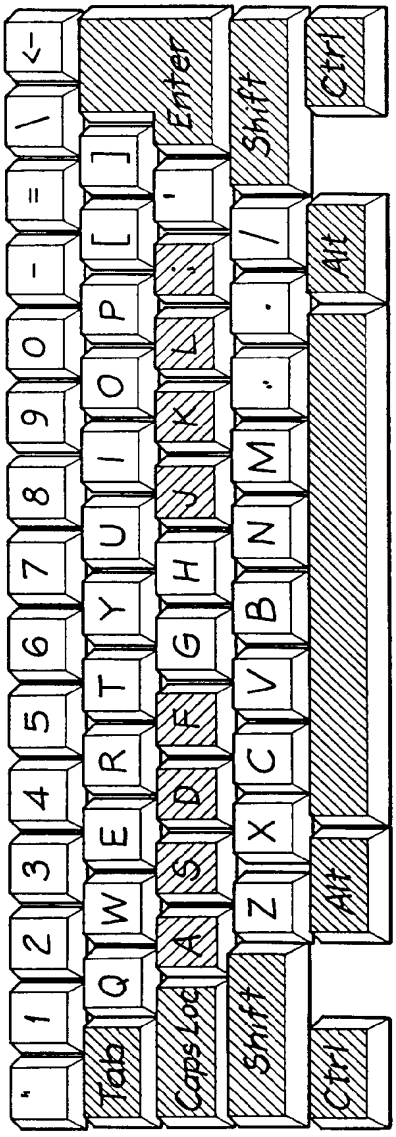
Tab
Caps Lock
Shift
Ctrl
Alt
Enter
Shift
Ctrl
Alt
1 2 3 4 5 6 7 8 9 0 - = \ <-
Q W E R T Y U I O P [ ] '
A S D F G H J K L ; :
Z X C V B N M , . /

FIG. 21

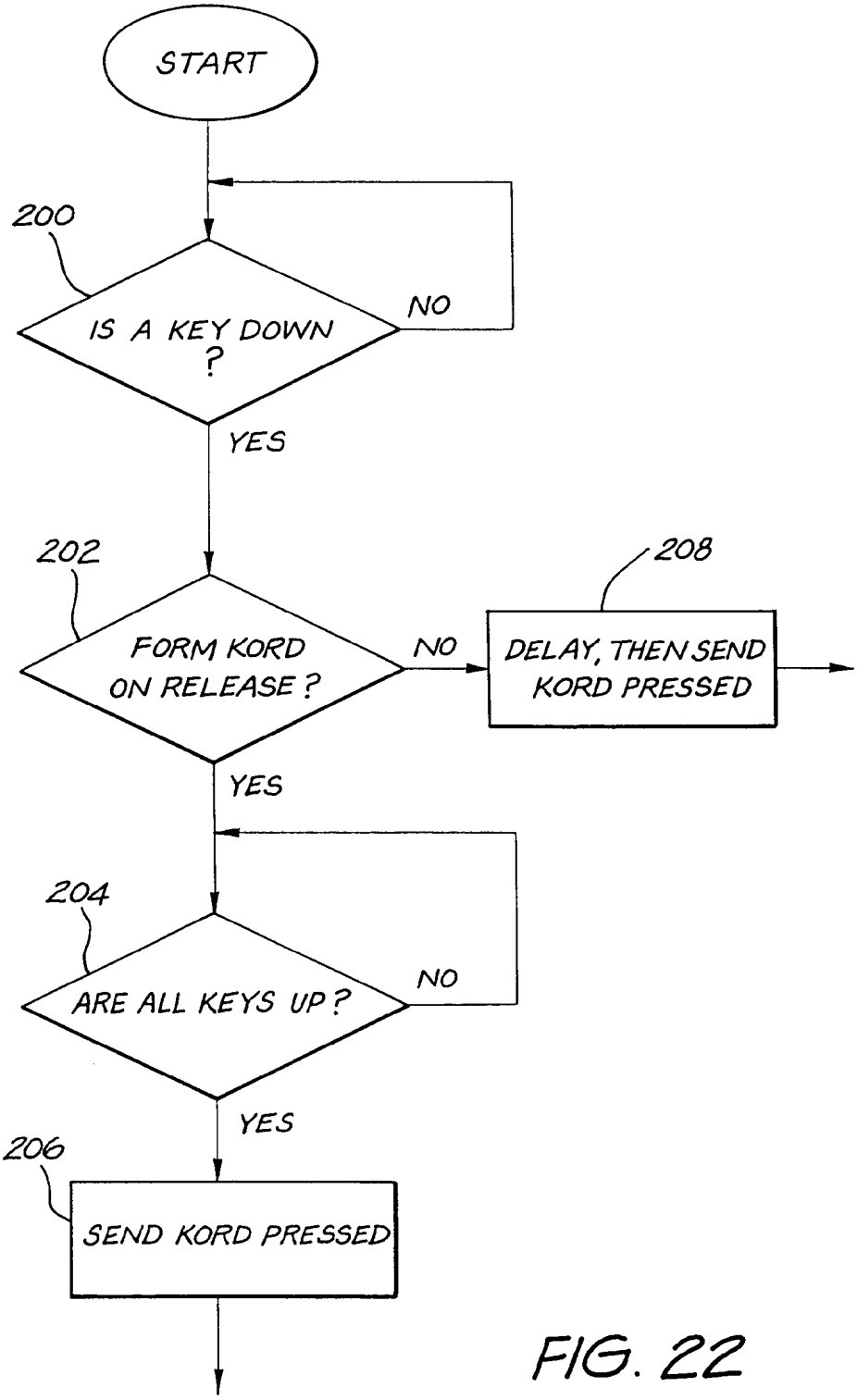
START
200
IS A KEY DOWN ?
NO
YES
202
FORM KORD ON RELEASE ?
NO
208
DELAY, THEN SEND KORD PRESSED
YES
204
ARE ALL KEYS UP ?
NO
YES
206
SEND KORD PRESSED

FIG. 22

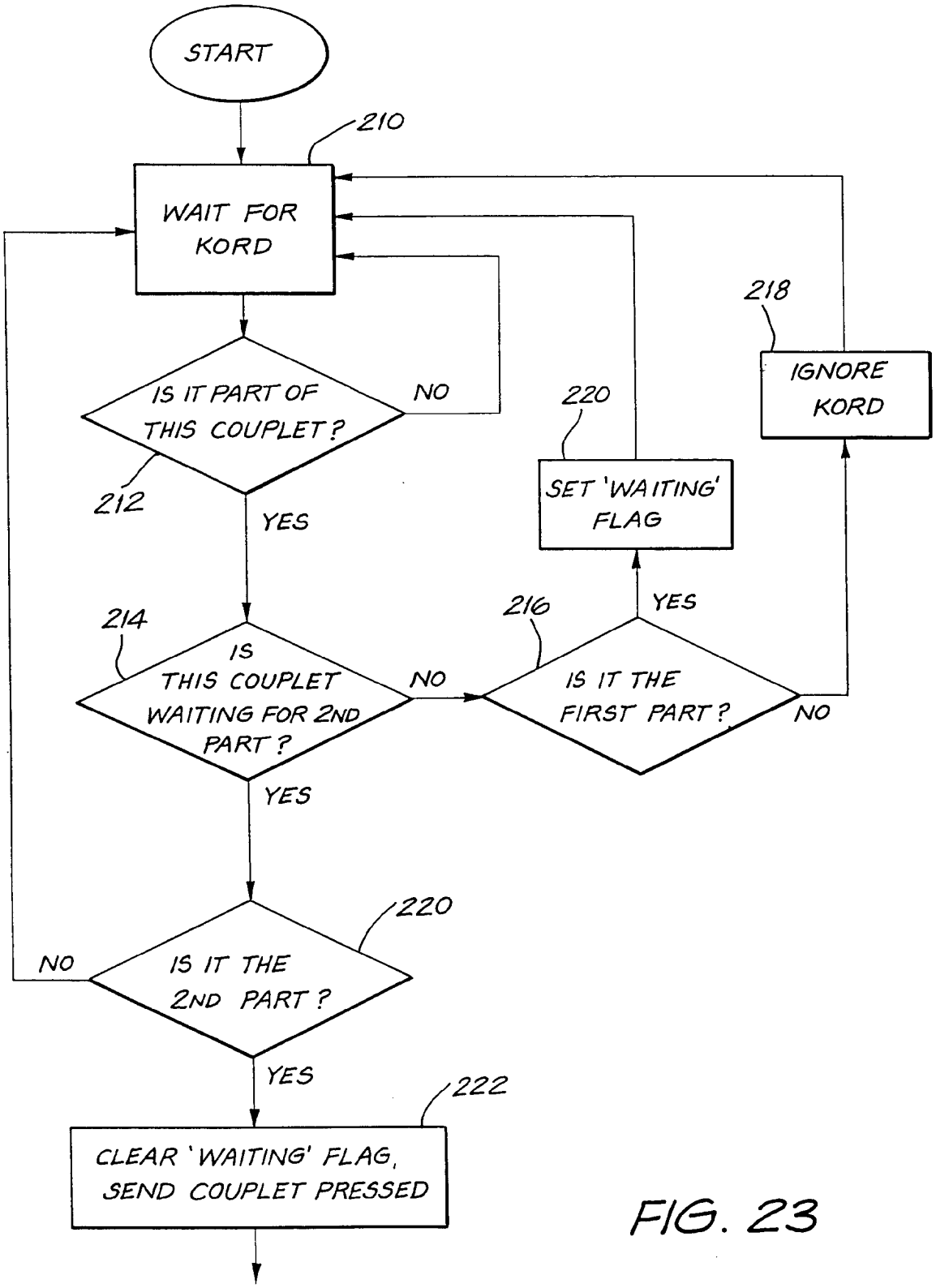
START
210
WAIT FOR KORD
IS IT PART OF THIS COUPLET ?
NO
212
YES
214
IS THIS COUPLET WAITING FOR 2ND PART ?
NO
YES
216
IS IT THE FIRST PART ?
NO
YES
220
SET 'WAITING' FLAG
218
IGNORE KORD
220
IS IT THE 2ND PART ?
NO
YES
222
CLEAR 'WAITING' FLAG, SEND COUPLET PRESSED

FIG. 23

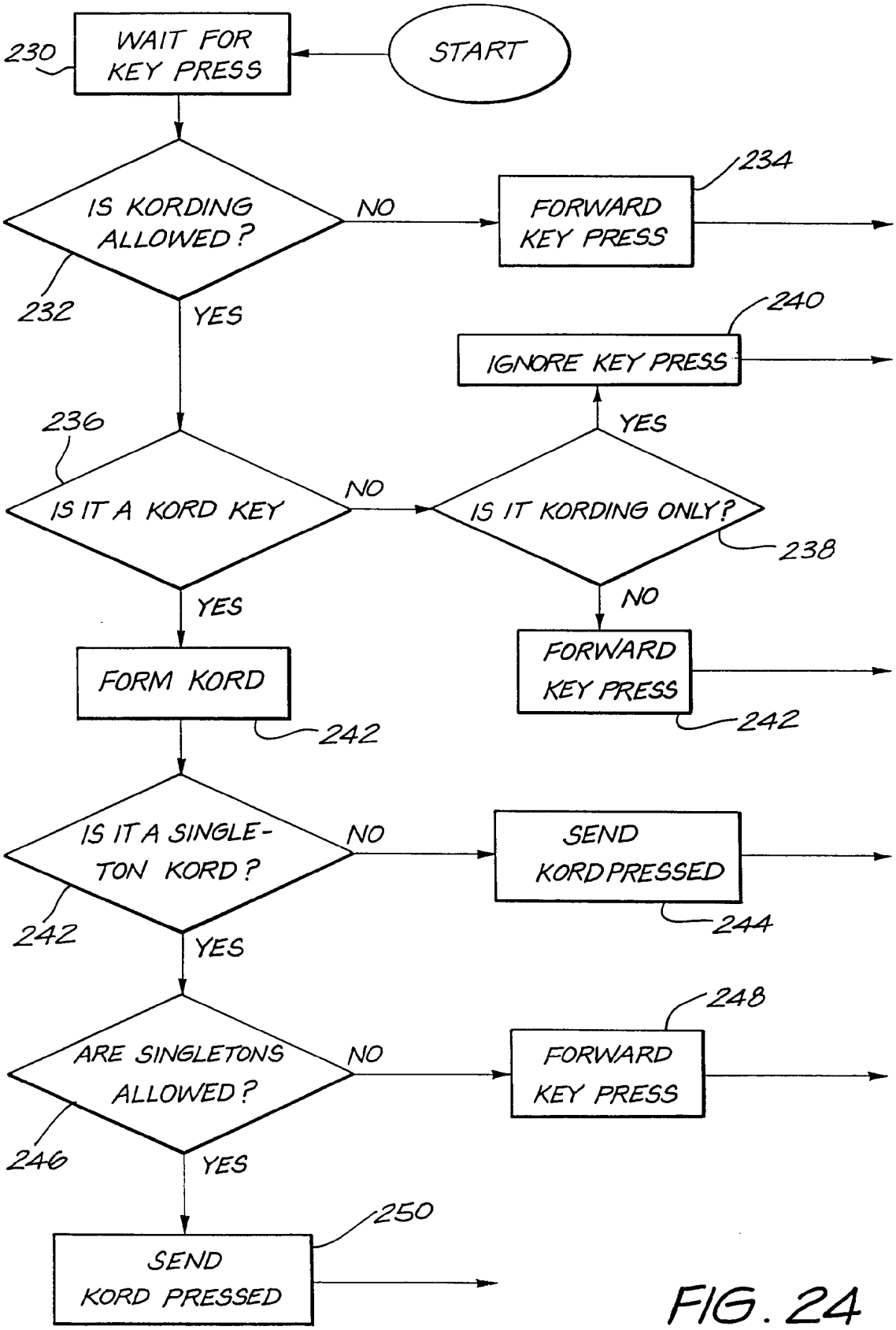
START
230
WAIT FOR KEY PRESS
IS KORDING ALLOWED?
NO
234
FORWARD KEY PRESS
232
YES
240
IGNORE KEY PRESS
YES
236
IS IT A KORD KEY
NO
IS IT KORDING ONLY?
238
YES
NO
FORM KORD
FORWARD KEY PRESS
242
242
IS IT A SINGLE-TON KORD?
NO
SEND KORD PRESSED
242
244
YES
248
ARE SINGLETONS ALLOWED?
NO
FORWARD KEY PRESS
246
YES
250
SEND KORD PRESSED

FIG. 24

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 95/00300

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[6] G06F 3/02, 3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F 3/02 3/14 3/147 3/153, G09B 13/00 13/02 13/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

DERWENT - KEY AND (CHORD OR HAND OR FINGER OR THUMB OR DIGIT)
JAPIO - KEY AND (CHORD OR HAND OR FINGER OR THUMB OR DIGIT)
CASSIS COMPUTER DATABASE
Ei COMPENDEX PLUS OCEANIC ABSTRACTS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	WO 94/06264 A1 (MARTESUO) 17 March 1994 WHOLE DOCUMENT	1-11
A	US 5087910 A (GUYOT-SIONNEST) 11 February 1992 COLUMN 7 LINE 36 TO COLUMN 8 LINE 15	1-11
A	US 4791408 A (HEUSINKVELD) 13 December 1988 WHOLE DOCUMENT	1-11

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 August 1995	22 AUGUST 1995
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer John Thomson **J W Thomson** Telephone No. (06) 2832214

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
A	WO 85/01914 A1 (STONE) 9 May 1985 PAGE 3 LINES 21-27, PAGE 9 LINE 21 TO PAGE 10 LINE 5	1-11
A	US 4458238 A (LEARN) 3 July 1984 COLUMN 2 LINE 10 TO COLUMN 3 LINE 4	1-11
A	FR 2386090 (DORMANN) 1 December 1978 ABSTRACT	1-11

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 95/00300

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	9406264	FI	91686				
US	5087910	AT	67907	CA	1297967	DE	3681660
		EP	213022	FR	2585487	JP	63036322
WO	8501914	AU	36195/84	DE	3482176	EP	163690
		JP	61500286	US	4555193		
							END OF ANNEX